METEOR SCATTER COMMUNICATIONS: THE SCIENCE BEHIND THE PINGS

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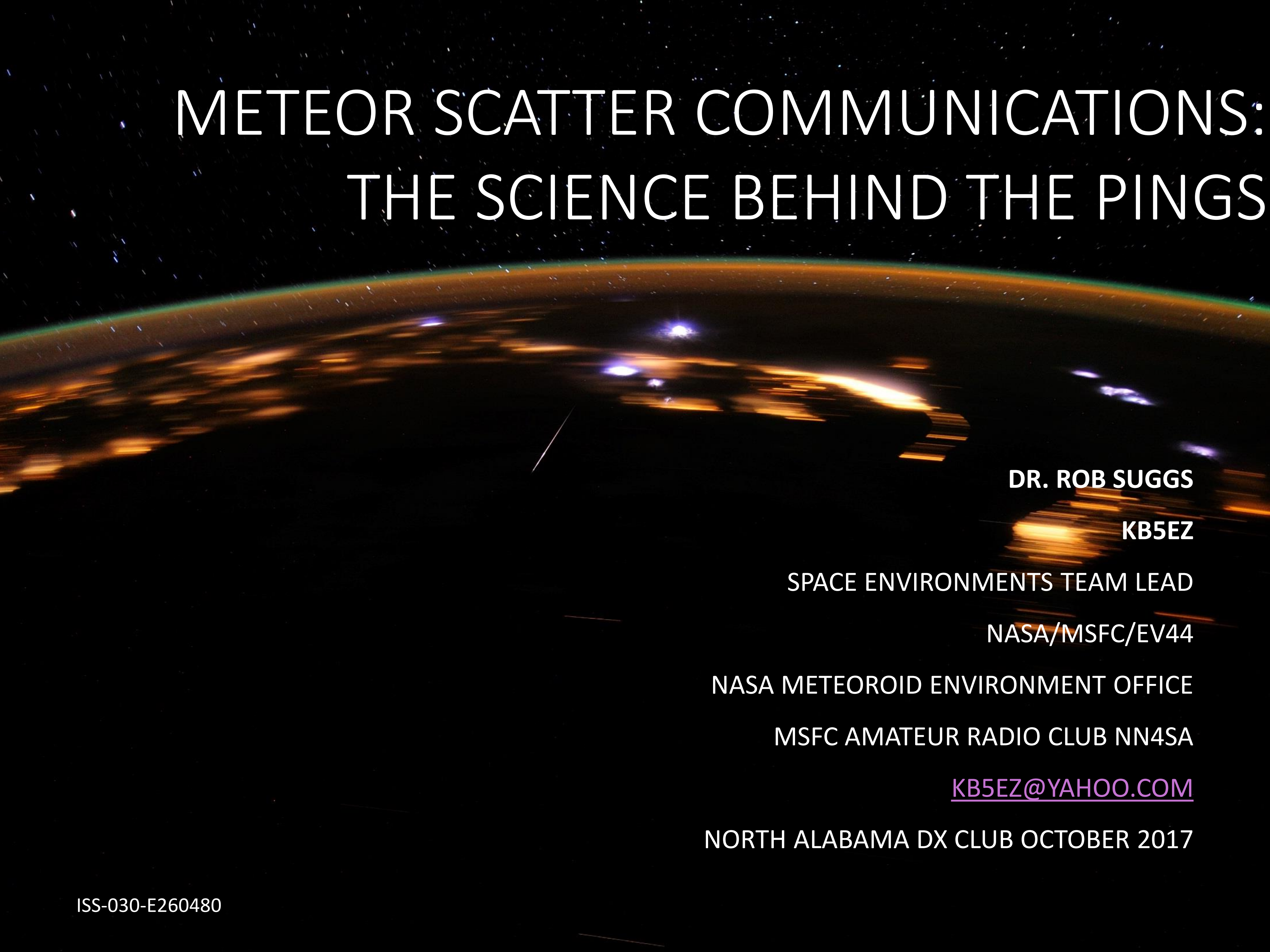
NORTH ALABAMA DX CLUB OCTOBER 2017



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OUTLINE

- What is a meteor?
- What scatters my signal?
- Where does my signal go?
- When is the best time to operate?
- What equipment should I use?
- What software and mode should I use?
- What does a QSO look and sound like?
- Tools to help make contacts
- Summary
- Links

} Science part

} Radio part

WHAT IS A METEOR?

- Consist of small pieces (grain of sand, particle of dust) of mostly cometary (90%) or asteroidal (10%) material
- Meteoroids – bits in space
- Meteors – bits burning up in the atmosphere
- Meteorites – hit the ground
- Visible light from a meteor comes mostly from the ionization of the atmosphere
- The free electrons from the ionization can scatter radio signals
- Sporadic meteors come from all over the sky (mostly), all the time but are most numerous near sunrise when we are on the front windshield of Earth
- Shower meteors appear to come from a point on the sky called the radiant
    - This is a perspective effect – like looking down a railroad track

ALL SKY CAMERA VIEW OF PERSEID 12 AUG 2017

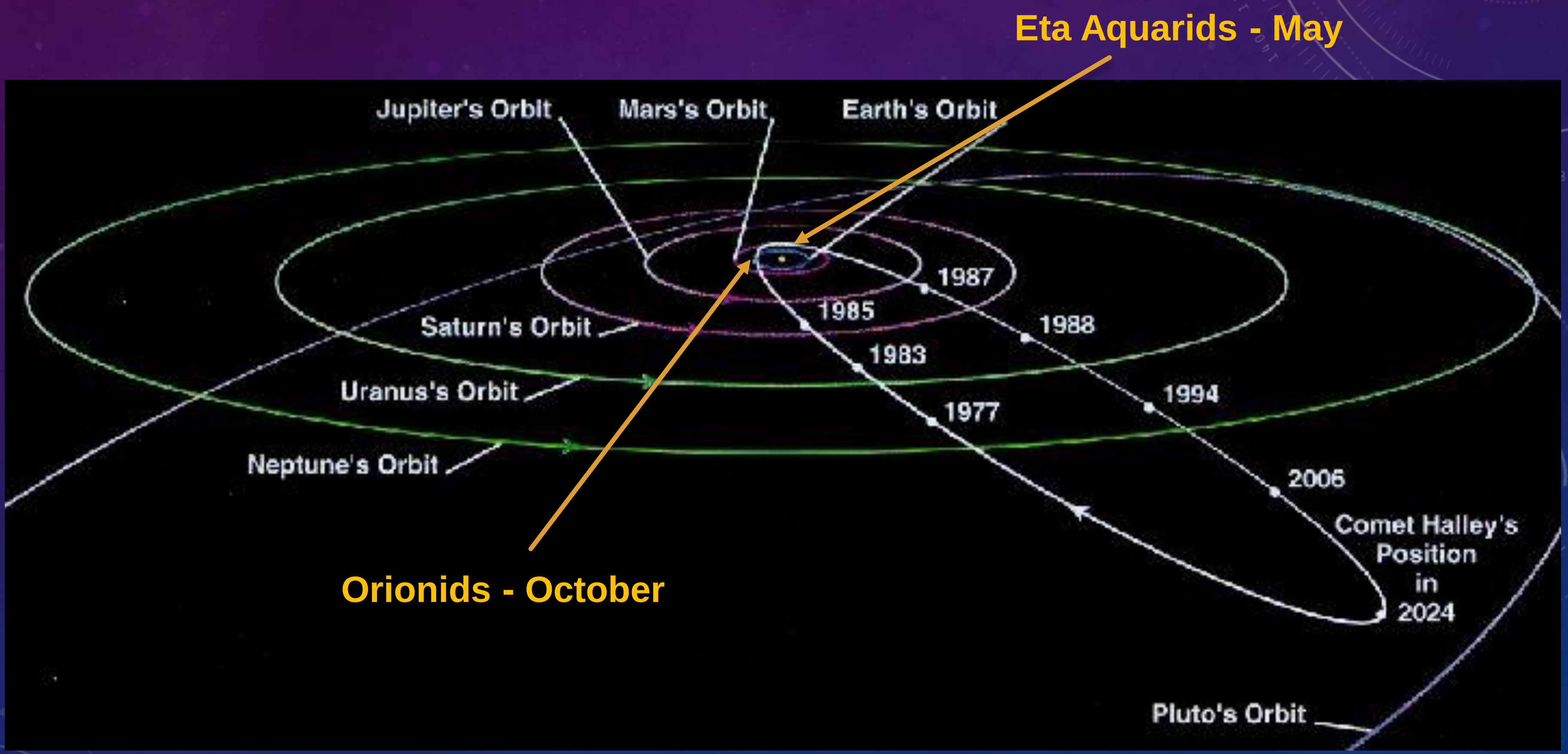
LEONIDS 1999

90% OF METEOROIDS COME FROM COMETS

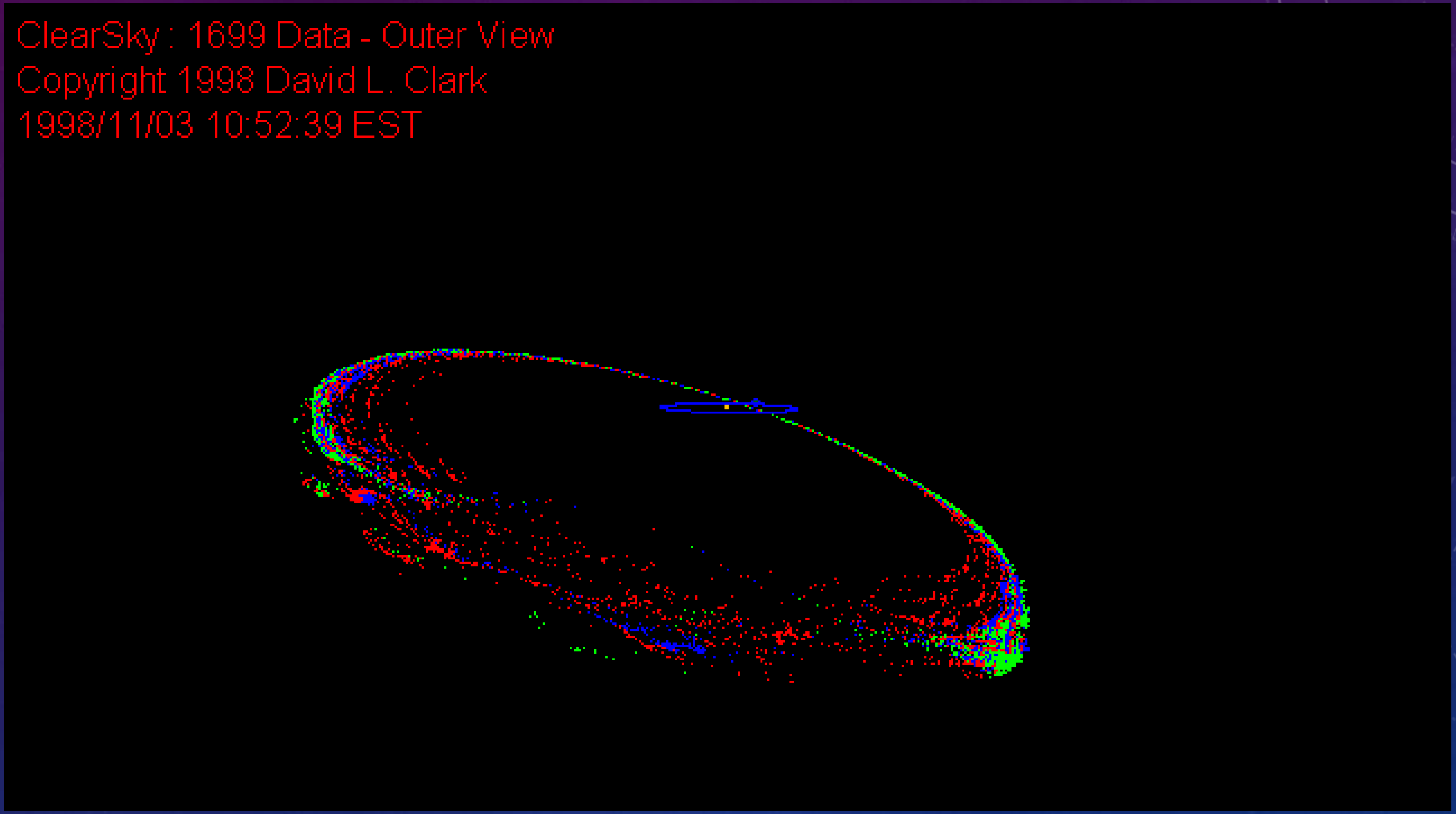
Comet Halley 1986

COMET HALLEY

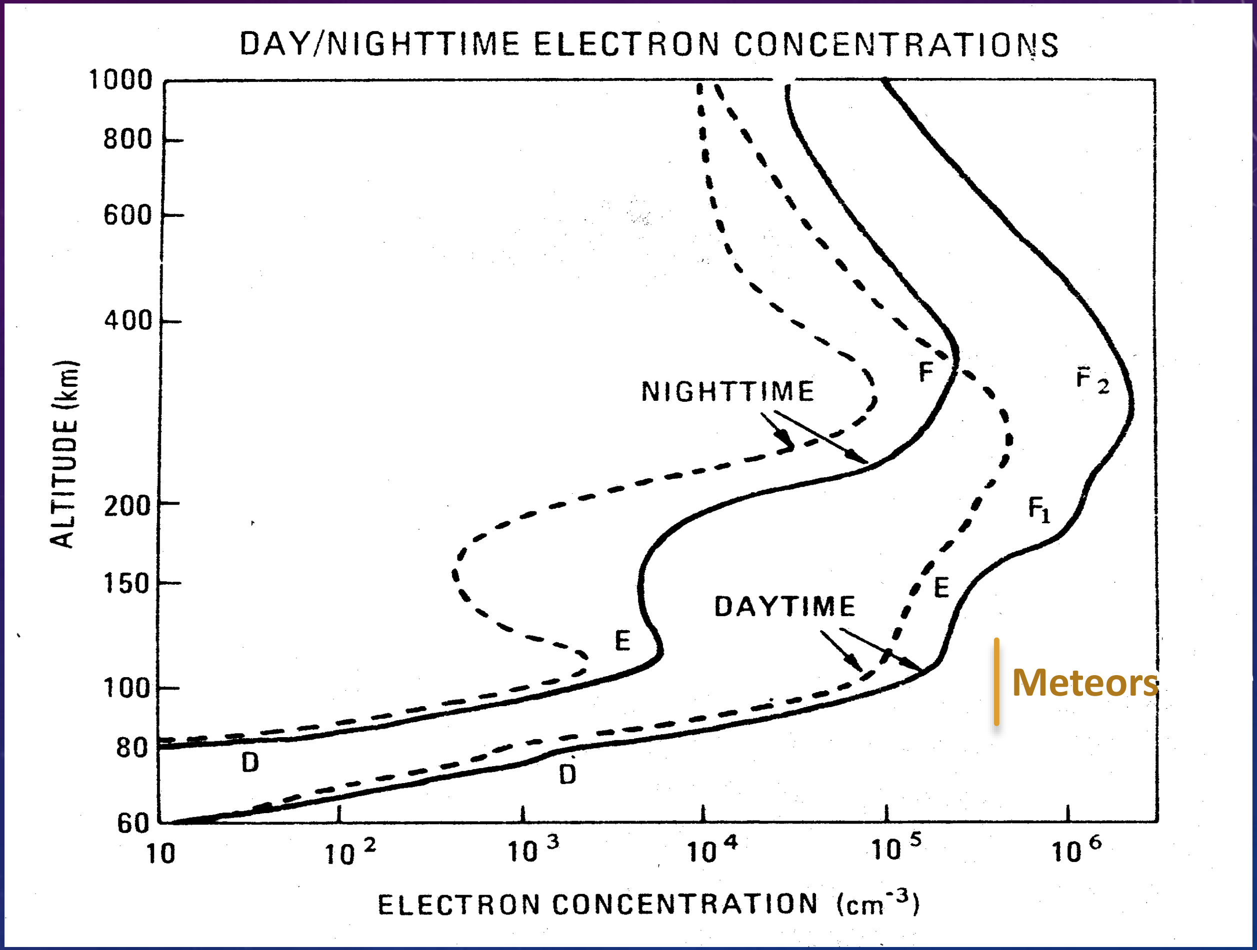
- Halley particles are responsible for 2 meteor showers every year



COMPUTER MODEL OF LEONID STREAM



IONOSPHERE

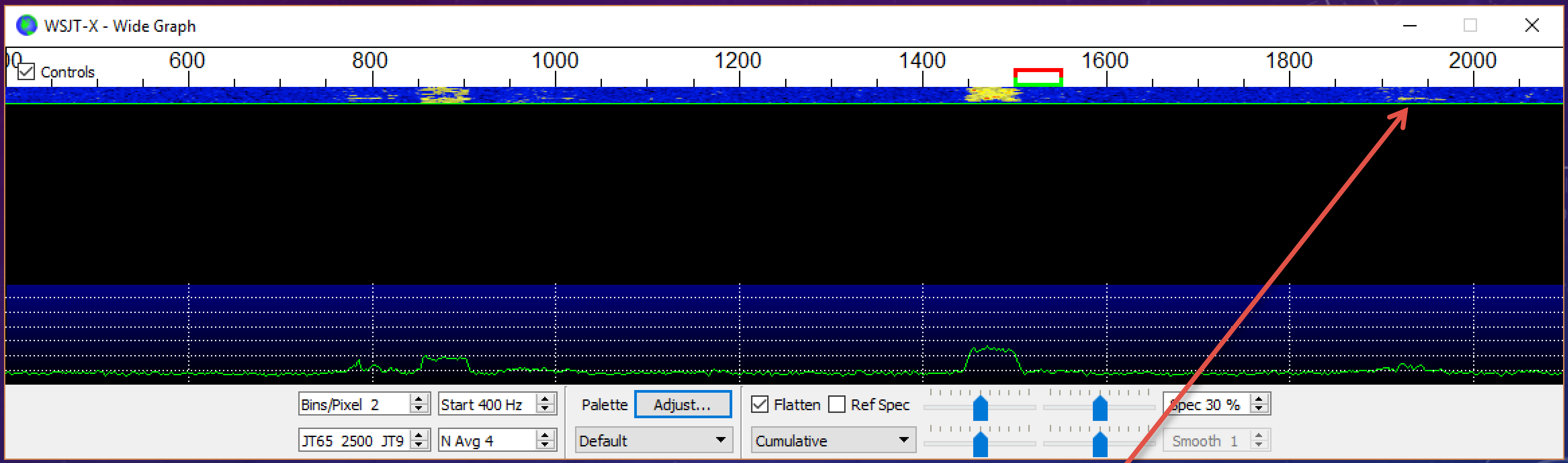


DAY/NIGHTTIME ELECTRON CONCENTRATIONS
ALTITUDE (km)
1000
800
600
400
200
150
100
80
60
10
10 2
10 3
10 4
10 5
10 6
ELECTRON CONCENTRATION (cm-3)
NIGHTTIME
DAYTIME
F
F 2
F1
E
E
D
D
Meteors

WHAT SCATTERS MY SIGNAL?

- As the meteoroid enters the atmosphere at high speed (15 – 70 km/s) it ionizes the oxygen and nitrogen molecules generating ions and free electrons which scatter the RF (also makes light)
- This occurs between about 100 and 80 km, near the same altitude as sporadic E (Es)
    - The only relationship between Es and meteors is that the electrons responsible for Es are thought to come from metals deposited in the atmosphere from meteor ablation.
    - But Es is not correlated with meteor showers
    - During summer you may work Es while attempting meteor scatter QSOs
        - Es gives longer-lasting signals

6m FT8 Meteor Ping
7 August 2017 02:45:15



170807_024515.wav

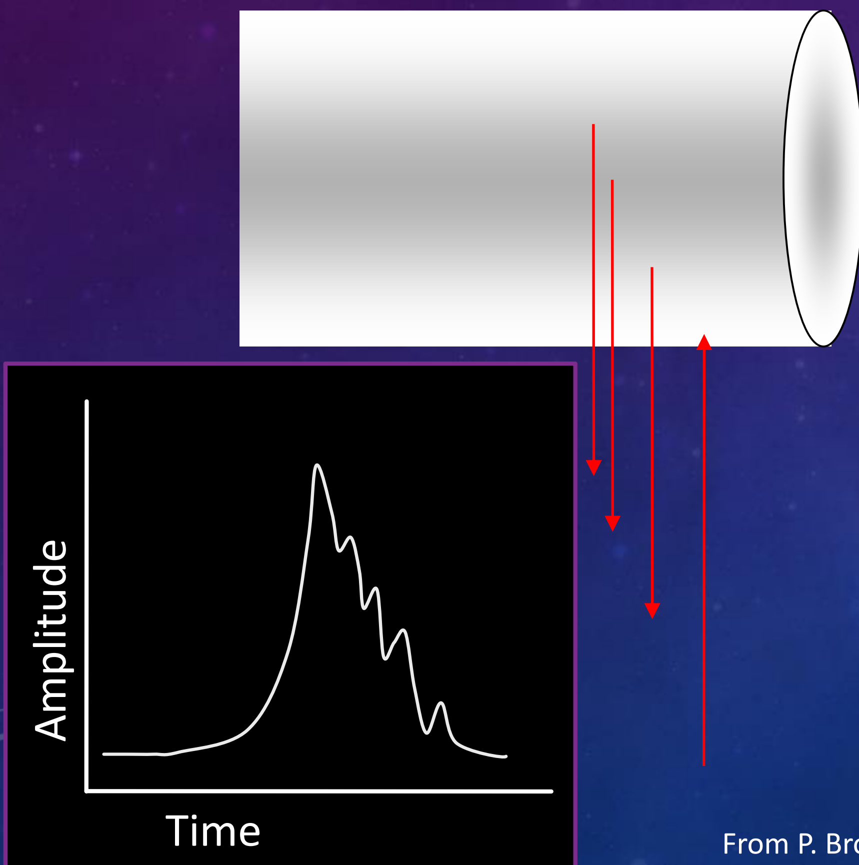
TWO TYPES OF METEOR TRAILS

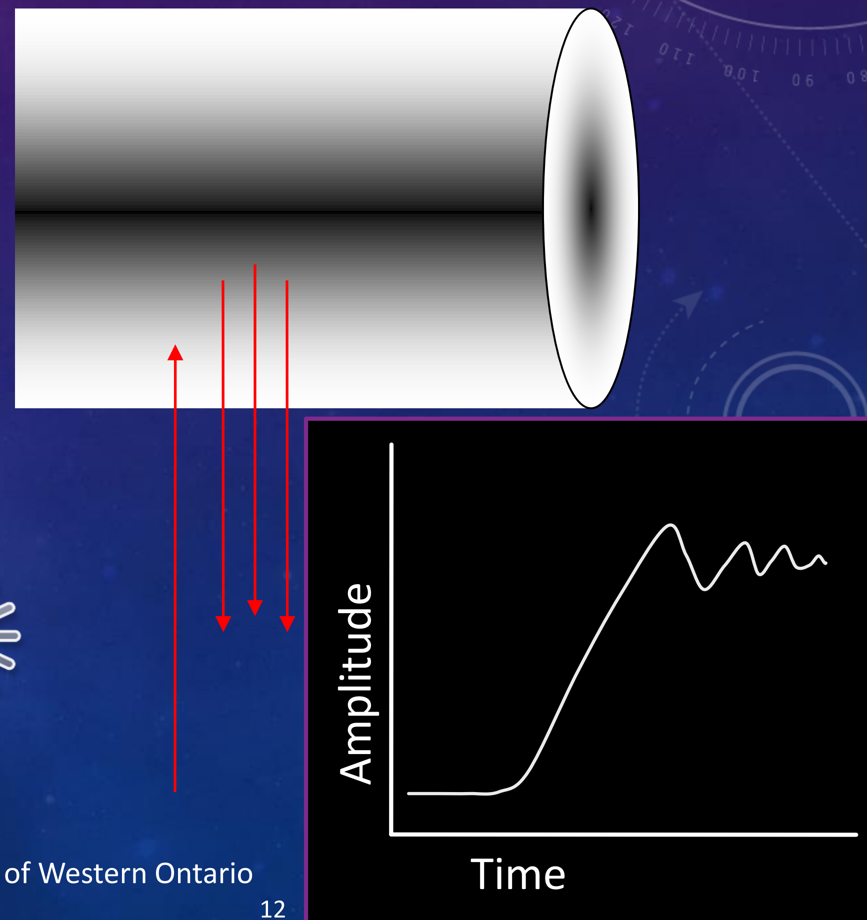
Underdense

- Weak echoes
- Short-lived (<1 second)
- Electron density is so low that individual electrons don't interact with each other)
- Scattering geometry must be specular

Overdense

- Strong echoes
- Long-lived (many seconds)
- Electrons act in concert like a metal tube
- Scattering geometry must be specular but upper atmospheric winds can "crinkle the tube"



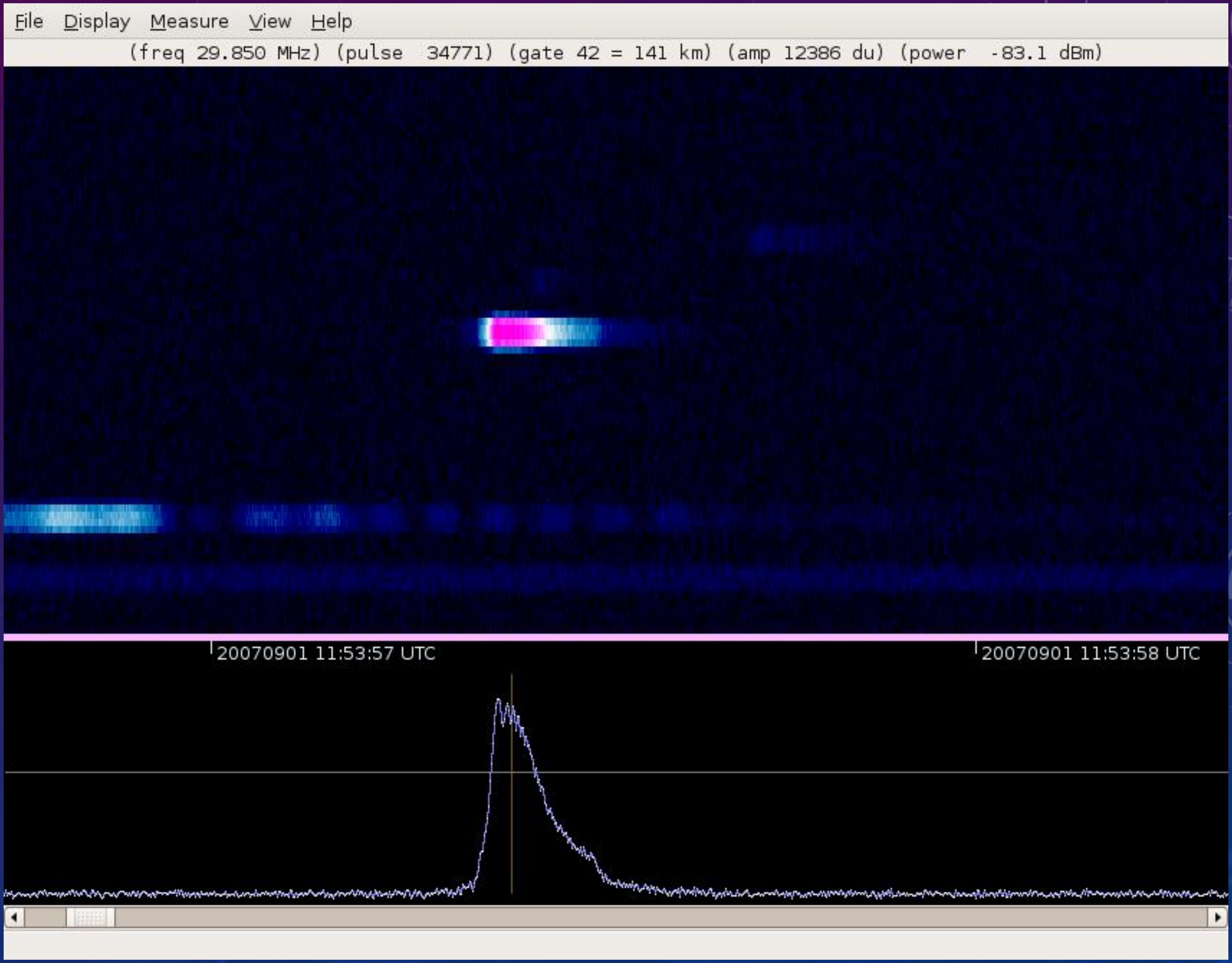


From P. Brown, Univ. of Western Ontario

UNDERDENSE EXAMPLE

ANOTHER LEONID

Underdense echo



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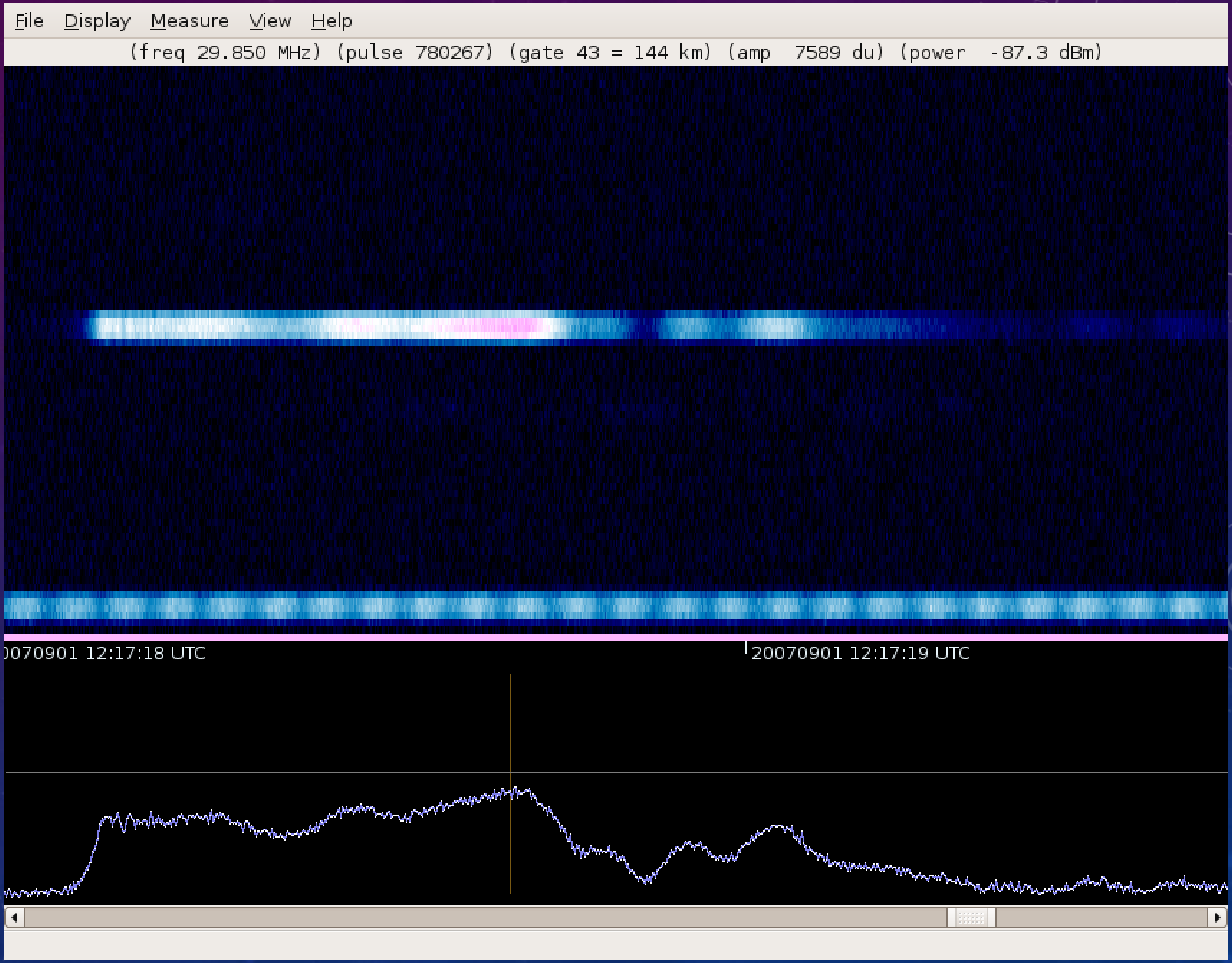
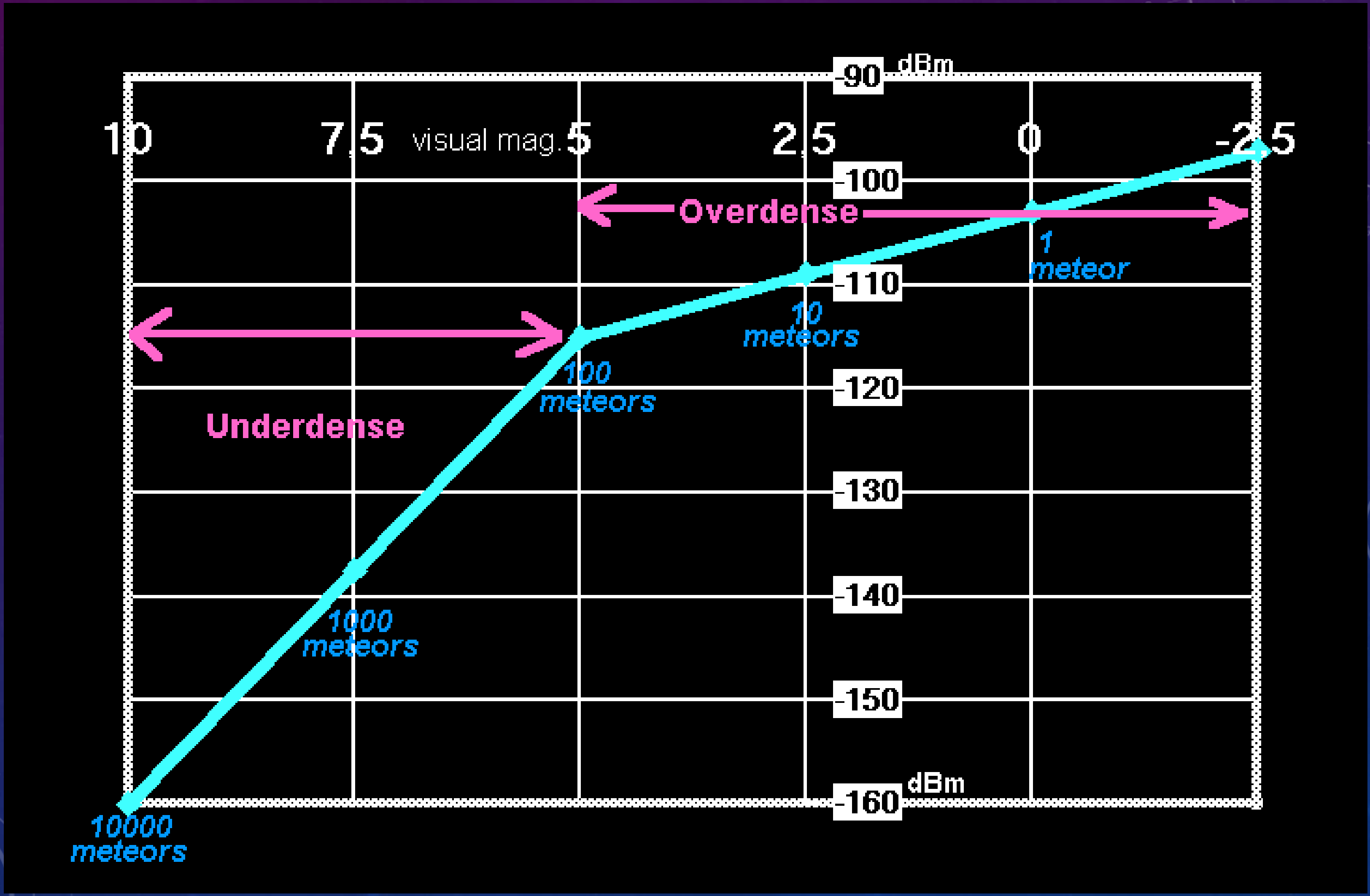
Overdense echo



From P. Brown, Univ. of Western Ontario

APPROXIMATE HOURLY METEOR RATES



RETURN POWER

Important point is that the signal strength goes as the cube of the wavelength, λ, and the square of the electron line density, q

$$P_R = \frac{P_T G_T G_R \lambda^3 \sigma_e}{64\pi^3} \frac{q^2 \sin^2 \gamma}{(R_1 R_2)(R_1 + R_2)(1 - \sin^2 \phi \cos^2 \beta)}$$

$$= 5 \times 10^{-32} \frac{P_T G_T G_R \lambda^3 q^2 \sin^2 \gamma}{(R_1 R_2)(R_1 + R_2)(1 - \sin^2 \phi \cos^2 \beta)} \quad \text{watts}$$

Also, the signal duration goes as the square of the wavelength.

You want to use the longest wavelength (lowest frequency) possible. If you get into HF bands, Ionospheric effects can dominate so lower VHF (40 – 100 MHz) is best. From McKinley, 1961.

FREQUENCY DEPENDENCE

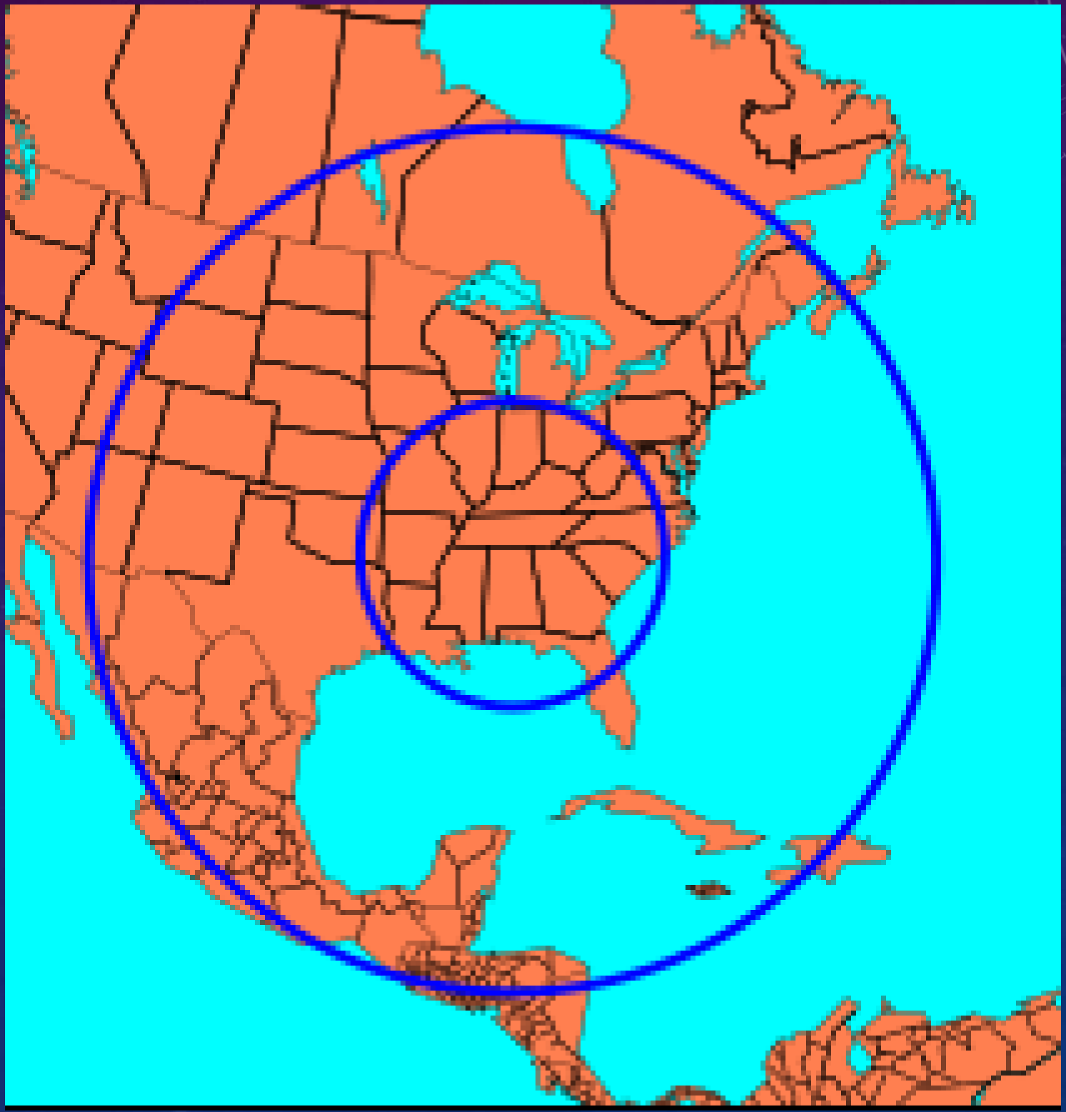
- Since scattered power is proportional to the wavelength^3 or 1/frequency^3 let's compare 2m to 6m

  $P \approx (50.26 / 144.2)^3 = 1/23.6$ or -13.7 dB, more than 2 S units

- But antenna gain is slightly easier at 2m
  - 3 element 6m yagi is 8 dBi (5 element ~ 16 dBi)
  - 11 element 2m yagi ~ 15 dBi
- But most HF rigs have 6m
- So 6m is favored especially if you don't already have the antennas and amplifier for 2m
- 10m should also work but is not typically used – beware signaling rate limitations (1200 baud – 10m) below VHF
  - Can't use MSK144

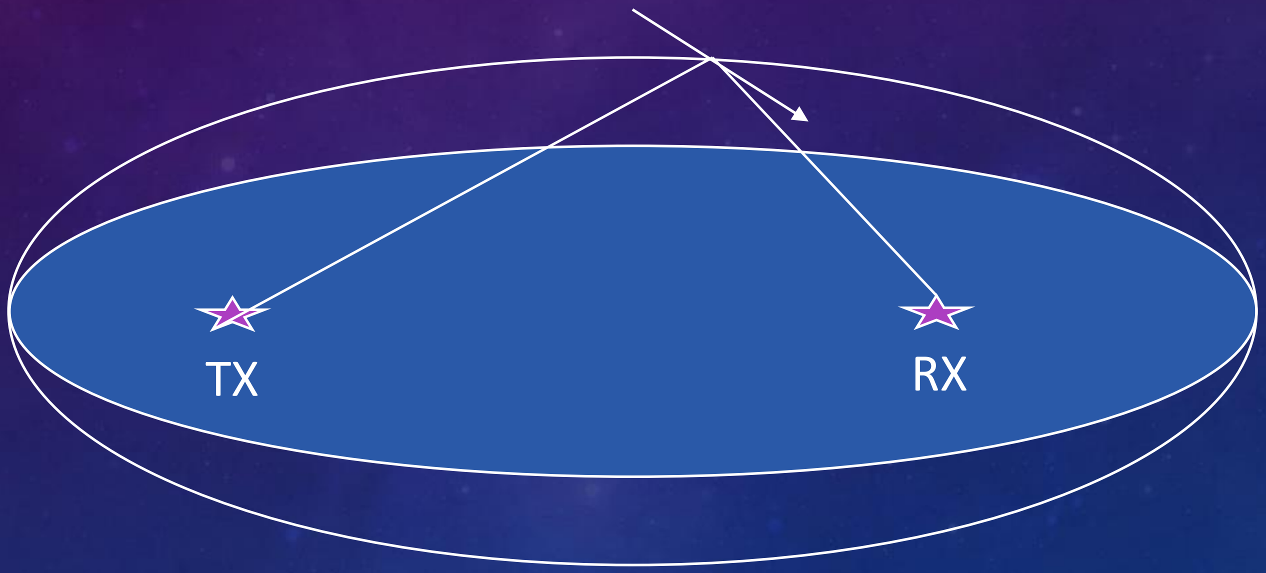
WHERE DOES MY SIGNAL GO?

TYPICAL RANGE: 800 – 2300 KM (500 – 1400 MI)



WHERE DOES MY SIGNAL GO?

- Meteor must lie tangent to an ellipsoid with the transmitter and receiver at the foci
- This geometry favors certain path directions as the shower radiant moves across the sky
- The vast majority of meteors don’t satisfy this ”specular” condition and can’t be used for communications

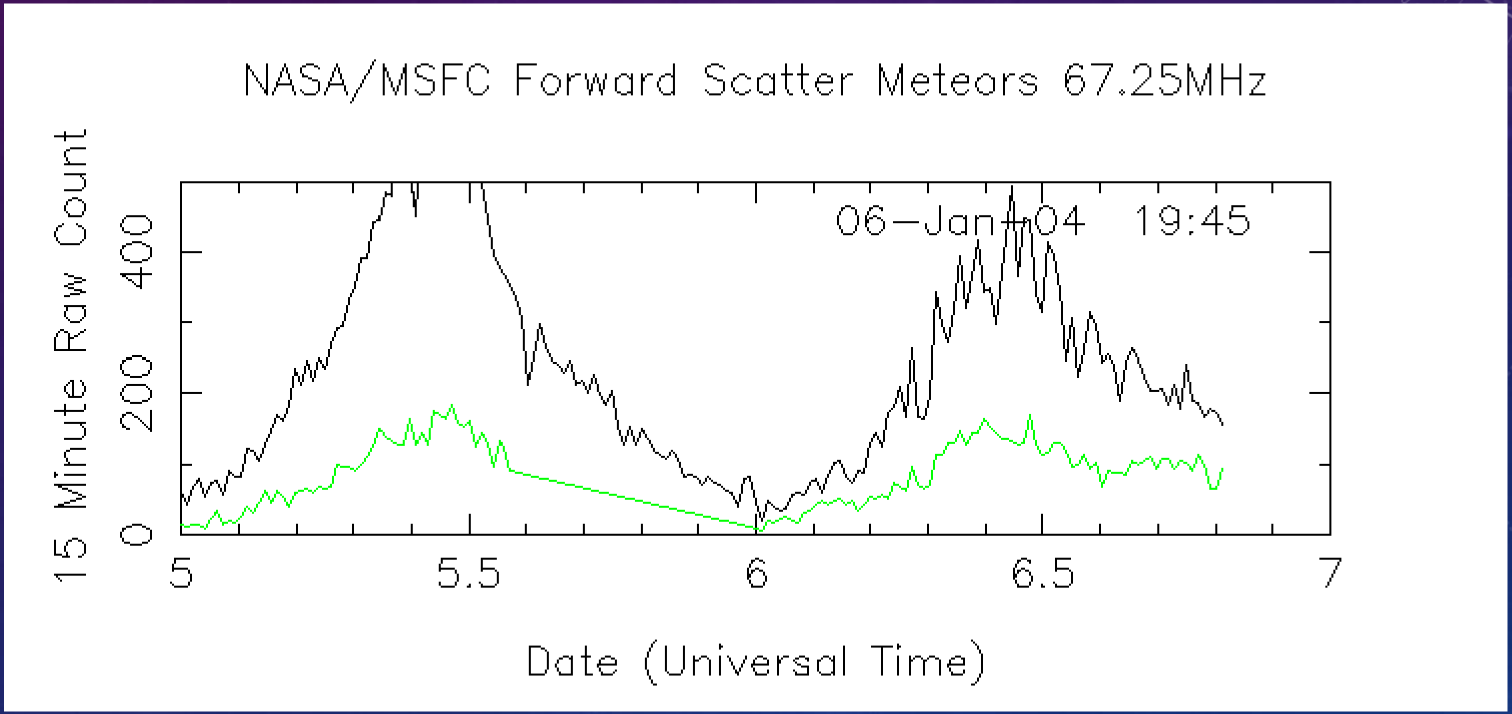


WHAT IS THE BEST TIME TO OPERATE?

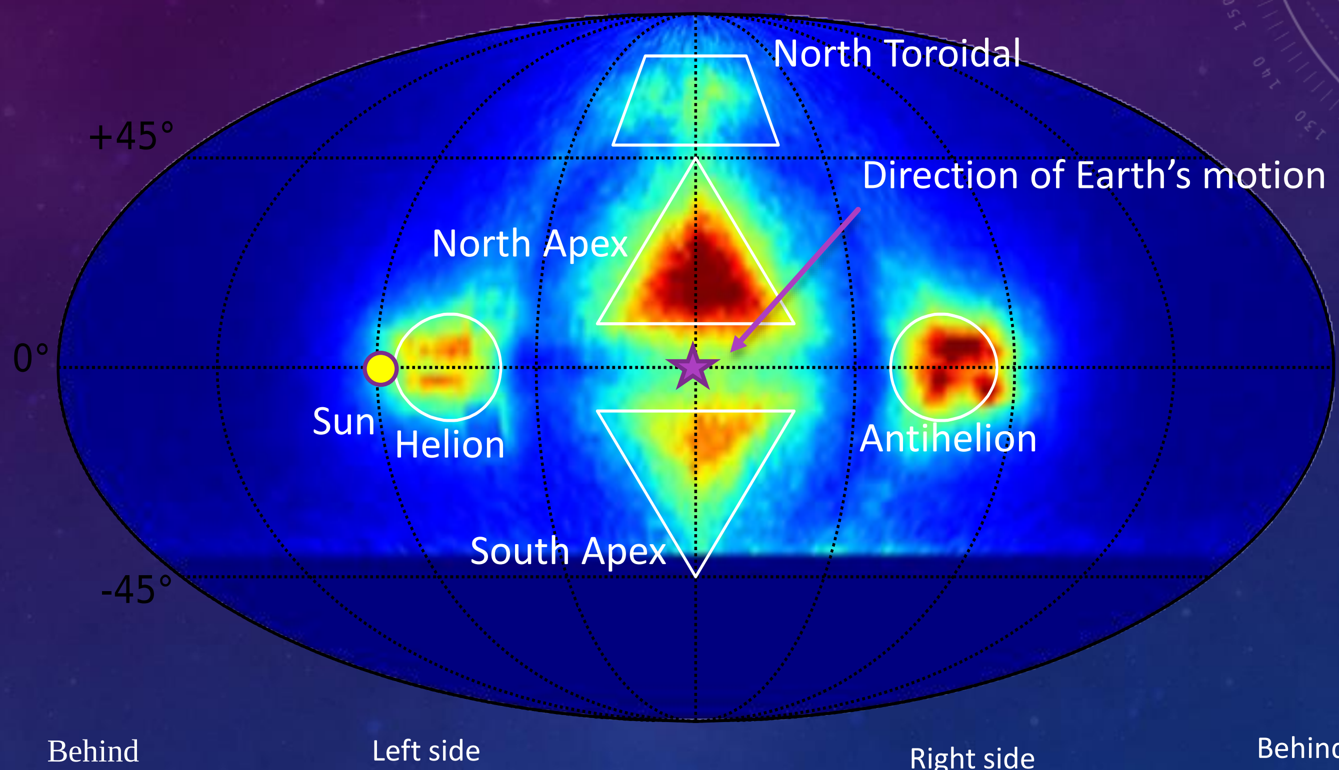
- Morning – diurnal variation – like bugs on a windshield
  - Car (Earth) going 30 km/s
  - Bugs (meteoroids) going up to 40 km/s around the sun, some head-on
  - Impact speed is vector sum of these (10 – 70 km/s) – all hit windshield, only really fast ones hit rear window
- There are fewer meteors in the spring, +/- 20% annual variation
- During meteor showers – there are more large meteors

Name	Peak Dates	Approx. Meteors/hour	Speed
Quandrantids	Jan. 3	120	43 km/s
Arietids	Jun. 9 (daytime)	45	41
Eta Aquariids	May 6	60	66
Perseids	Aug. 11-13	90	60
Orionids	Oct. 20-22	20	67
Geminids	Dec. 12-13	120	36

2004 QUADRANTID METEOR SHOWER



SPORADIC SOURCE RADIANTS FROM RADAR



Meteoroid Flux as a function of direction as observed by Canadian Meteor Orbit Radar. Observational biases have been taken into account and results have been weighted by a constant limiting kinetic energy. Coordinate system is Earth-centered ecliptic.

WHAT EQUIPMENT SHOULD I USE?

- Most modern HF rigs include 6m
  - Throttle back from max power for high duty cycle like MSK144 (50 - 75%)
- Antenna gain helps – 5 element beam on 6m is good
  - An amplifier and mast-mounted preamp help
  - It is possible to make contacts with attic-mounted dipoles – be patient and make a sched with a big gun
- Most modern computers have adequate processing power
  - May need to reduce Frequency Tolerance (FTOL below 200 Hz)
- Need a soundcard interface
  - Many new rigs have this built-in
  - SignaLink is very popular
  - Homebrew is fairly simple

NN4SA Club Station

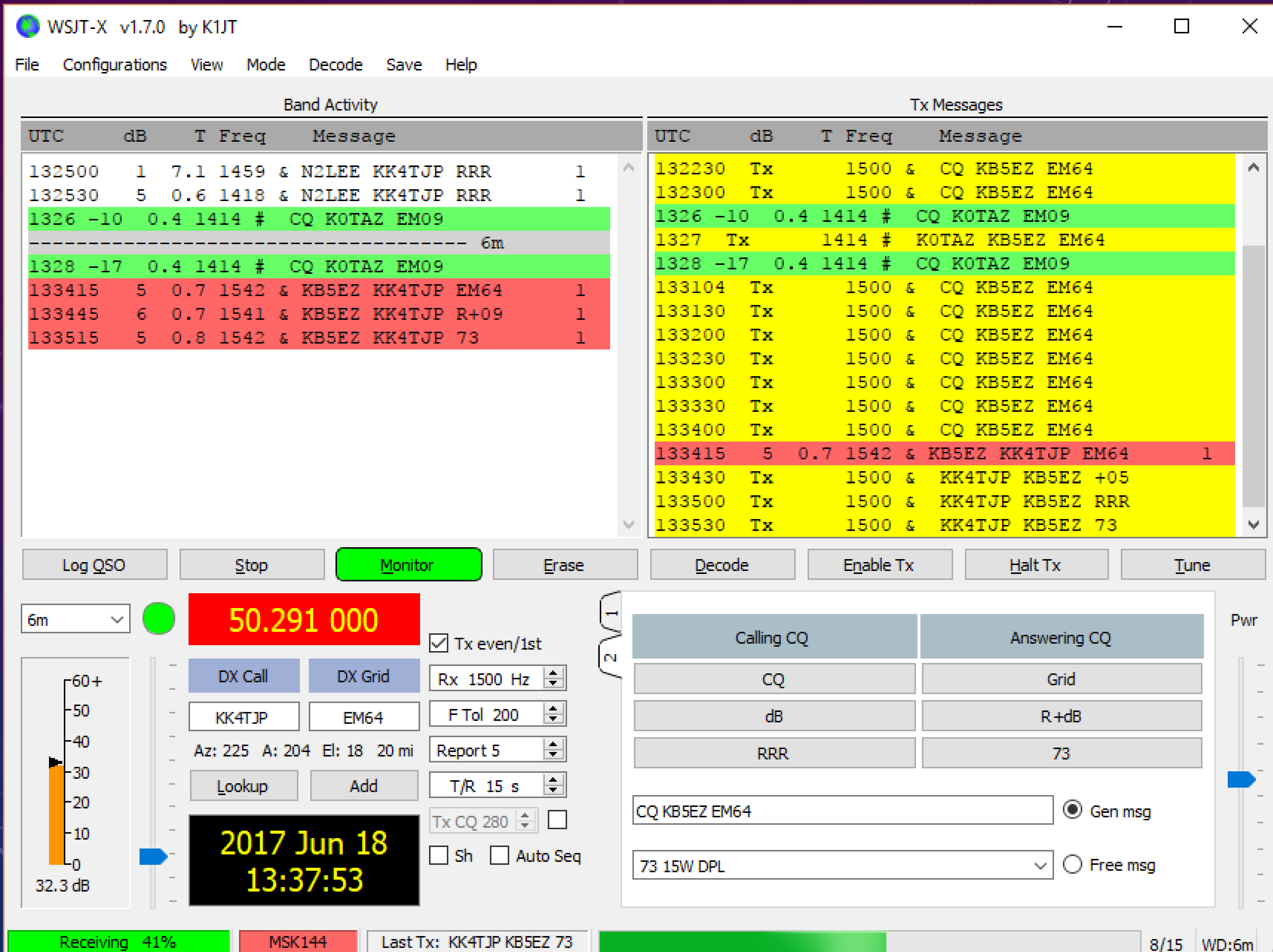
WHAT SOFTWARE AND MODE SHOULD I USE?

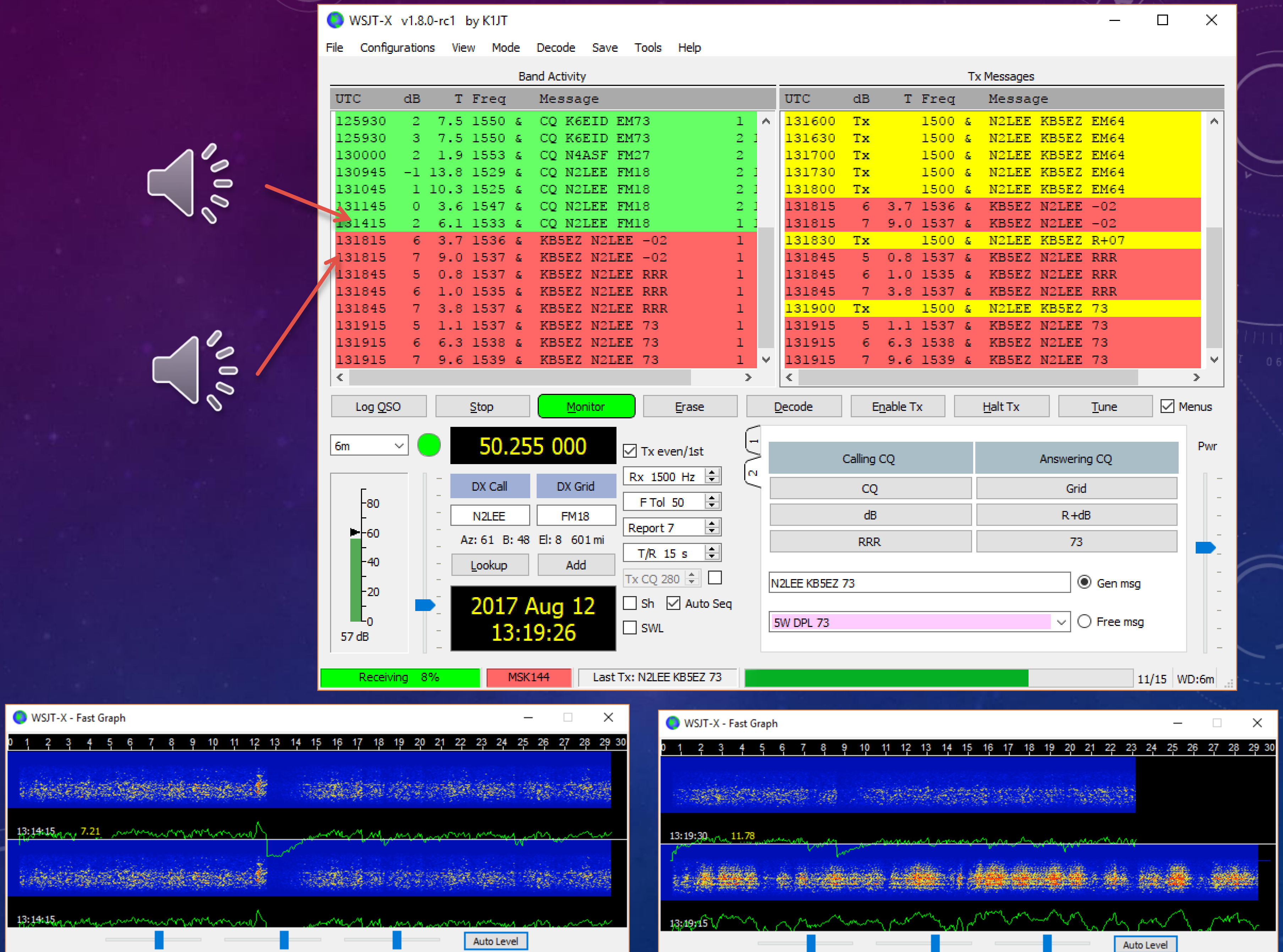
- WSJT-X has the MSK144 mode which is the standard
  - Available for Windows, Mac and Linux
  - 15 second cycle is typically used, messages are 72 msec
  - Offset quadrature phase shift keying (minimum shift keying)
  - PC clock should be set accurately, within a second or so
  - The WSJT Yahoogroup is excellent but READ THE MANUAL FIRST
- Previous versions of WSJT had the FSK441 mode which has faded from use
- Longer format modes like JT65 and FT8 are too slow
  - Recall that most “pings” are a second or two
- CW and SSB are possible but are more difficult

WHAT DOES A QSO LOOK AND SOUND LIKE?

- MSK144 sounds more like a grunt than a ping
- The QSO sequence looks just like JT65/JT9/FT8
- Operators' choice whether exchanging signal reports or grid squares or usually both
- Auto Sequence mode of MSK144 makes the QSO easy

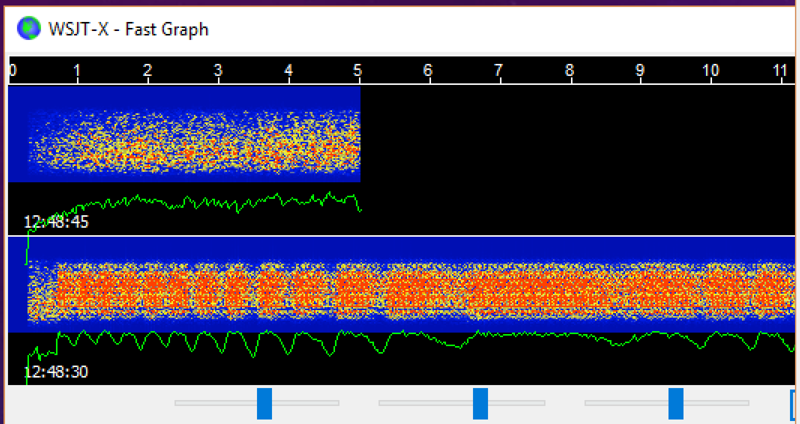
LOCAL CONTACT USING MSK144

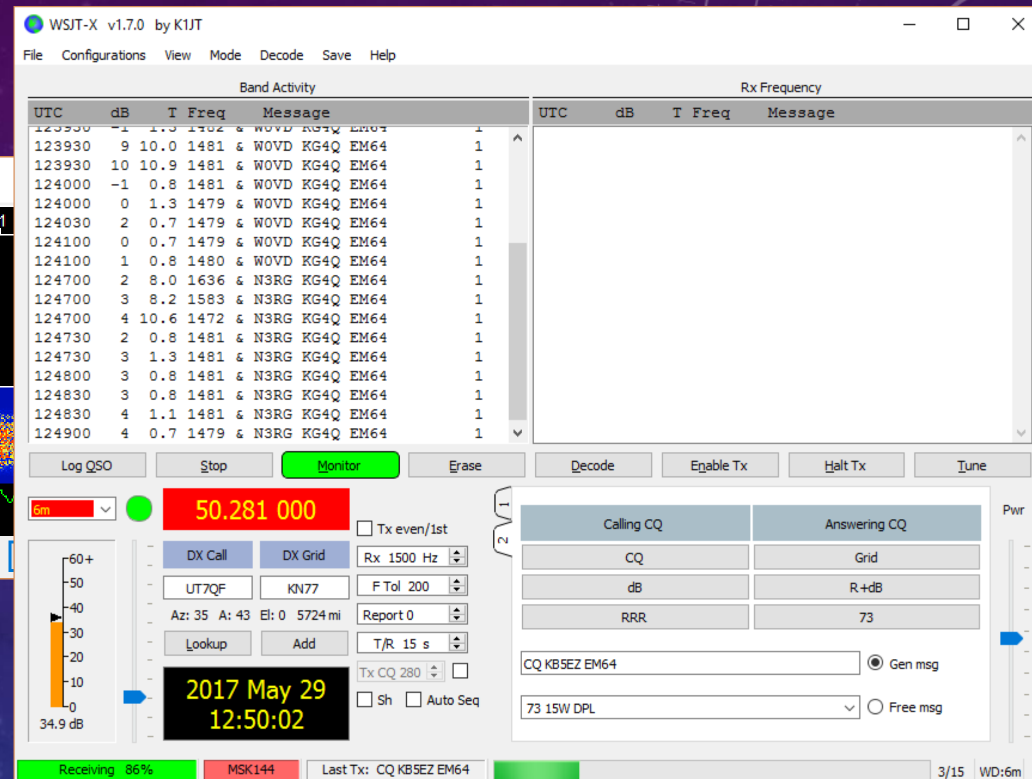


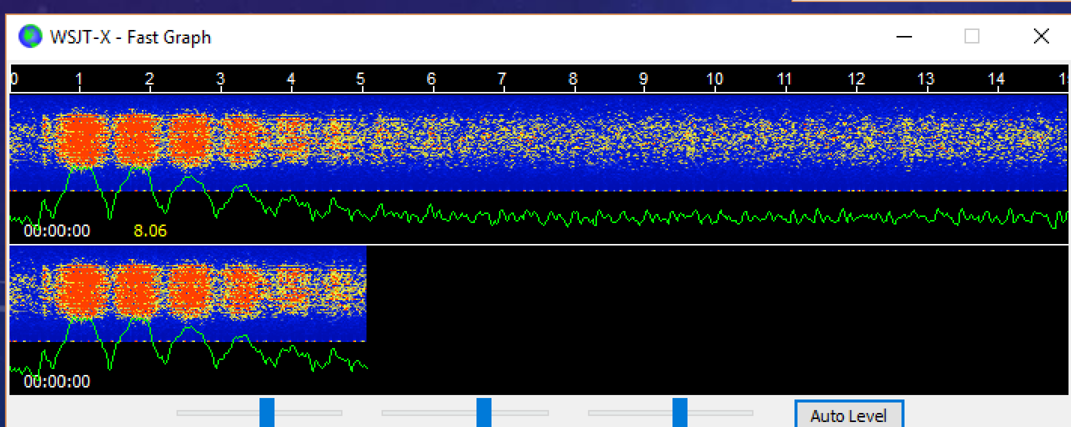


WSJT-X v1.8.0-rc1 by K1JT
File Configurations View Mode Decode Save Tools Help
Band Activity
UTC dB T Freq Message
125930 2 7.5 1550 & CQ K6EID EM73 1
125930 3 7.5 1550 & CQ K6EID EM73 2
130000 2 1.9 1553 & CQ N4ASF FM27 2
130945 -1 13.8 1529 & CQ N2LEE FM18 2
131045 1 10.3 1525 & CQ N2LEE FM18 2
131145 0 3.6 1547 & CQ N2LEE FM18 2
131415 2 6.1 1533 & CQ N2LEE FM18 1
131815 6 3.7 1536 & KB5EZ N2LEE -02 1
131815 7 9.0 1537 & KB5EZ N2LEE -02 1
131845 5 0.8 1537 & KB5EZ N2LEE RRR 1
131845 6 1.0 1535 & KB5EZ N2LEE RRR 1
131845 7 3.8 1537 & KB5EZ N2LEE RRR 1
131915 5 1.1 1537 & KB5EZ N2LEE 73 1
131915 6 6.3 1538 & KB5EZ N2LEE 73 1
131915 7 9.6 1539 & KB5EZ N2LEE 73 1
Tx Messages
UTC dB T Freq Message
131600 Tx 1500 & N2LEE KB5EZ EM64
131630 Tx 1500 & N2LEE KB5EZ EM64
131700 Tx 1500 & N2LEE KB5EZ EM64
131730 Tx 1500 & N2LEE KB5EZ EM64
131800 Tx 1500 & N2LEE KB5EZ EM64
131815 6 3.7 1536 & KB5EZ N2LEE -02
131815 7 9.0 1537 & KB5EZ N2LEE -02
131830 Tx 1500 & N2LEE KB5EZ R+07
131845 5 0.8 1537 & KB5EZ N2LEE RRR
131845 6 1.0 1535 & KB5EZ N2LEE RRR
131845 7 3.8 1537 & KB5EZ N2LEE RRR
131900 Tx 1500 & N2LEE KB5EZ 73
131915 5 1.1 1537 & KB5EZ N2LEE 73
131915 6 6.3 1538 & KB5EZ N2LEE 73
131915 7 9.6 1539 & KB5EZ N2LEE 73
Log QSO
Stop
Monitor
Erase
Decode
Enable Tx
Halt Tx
Tune
Menus
6m
50.255 000
Tx even/1st
Rx 1500 Hz
F Tol 50
Report 7
T/R 15 s
Tx CQ 280
Sh
Auto Seq
SWL
DX Call
DX Grid
N2LEE
FM18
Az: 61 B: 48 El: 8 601 mi
Lookup
Add
2017 Aug 12
13:19:26
80
60
40
20
0
57 dB
Calling CQ
Answering CQ
CQ
Grid
dB
R+dB
RRR
73
N2LEE KB5EZ 73
Gen msg
5W DPL 73
Free msg
Pwr
Receiving 8%
MSK144
Last Tx: N2LEE KB5EZ 73
11/15
WD:6m
WSJT-X - Fast Graph
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
13:14:15
7.21
13:14:15
Auto Level
WSJT-X - Fast Graph
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
13:19:30
11.78
13:19:15
Auto Level

KG4Q AIRCRAFT SCATTER 12:48 29 MAY







TOOLS TO HELP MAKE CONTACTS

- Pingjockey.net
  - Great way to setup a contact
    - Agree on frequency and timing
  - DO NOT post info during the QSO if you want it to “count”
- University of Western Ontario radar site
  - Indicates which showers are active
  - 15 kW radar at 17.45, 29.85, and 38.15 MHz
  - The system can’t see meteors from radiants directly overhead
  - It loses sensitivity for higher speed meteors (initial trail radius)

PINGJOCKEY.NET

Ping Jockey Central by N

www.pingjockey.net/cgi-bin/pingtalk

Apps | Balun 4:1 | Ham radio | Bible study | MSFC Automated Lun | Rasp Pi | Keeping it Clean: CPA

The information that is stored in the cookie is your callsign, firstname, and Maidenhead grid locator.
To enable this feature, please press the "Update User details" button shown above.

Enter your message here [ ] Go!

```
DDMMM  UTC
23Apr 12:29 ~ QRV ~ 144140 ~    (K0TPP Larry mo EM48rj 71.11.138.45)
23Apr 12:29 RR  (WA5ZFP Ron LA EL49vw 162.203.219.199)
23Apr 12:29 CQ Stopped  (W5SAT Brad NV DM26kc 72.193.208.187)
23Apr 12:29 OK ROn - I'm with you now.  (K1JT/7EL700W Joe NJ FN20qi 173.71.96.3)
23Apr 12:27 Tnx QSO Ken (K1JT/7EL700W Joe NJ FN20qi 173.71.96.3)
23Apr 12:26 K1JT Joe, 122545  18 12.5 1488 & W8KEN K1JT RRR         2  0  0.0 - in the log, 73, ken     (W8KEN/6/2 Ken OH EN9
23Apr 12:26 Thanks Ron   122430  12  0.7 1492 & WA4PGM WA5ZFP 73        1  0  0.3  122430  13  5.1 1498 & WA4PGM WA5ZFP 73
23Apr 12:25 K1JT CALLING        (WA5ZFP Ron LA EL49vw 162.203.219.199)
23Apr 12:25 kn4jx Tommy, What is your station setup PSE?        (N0KK/6/2/QRO Kirk MN EN35ha 97.116.169.177)
23Apr 12:24  122415   5  6.0 1516 & WA5ZFP WA4PGM RRR      1    (WA5ZFP Ron LA EL49vw 162.203.219.199)
23Apr 12:24 TU Kirk     (KN4JX Tommy MO EM37wn 72.160.171.43)
23Apr 12:23 122245   4 12.7 1470 & N0KK KN4JX RRR   1  4 -0.4  TU QSO!  (N0KK/6/2/QRO Kirk MN EN35ha 97.116.169.177)
23Apr 12:23 K1JT Joe, GM Joe - Tnx New Contact - 73, Ken        (W8KEN/6/2 Ken OH EN91im 184.59.132.46)
23Apr 12:22 RR Ron      (K1JT/7EL700W Joe NJ FN20qi 173.71.96.3)
23Apr 12:20 K1JT when you finish        (WA5ZFP Ron LA EL49vw 162.203.219.199)
23Apr 12:16 Nice signals up here, Ron   (N8OC Dave MI EN83ao 75.133.95.71)
23Apr 12:15  121445   0 12.3 1484 & WA5ZFP N8OC 73          3 thanks     (WA5ZFP Ron LA EL49vw 162.203.219.199)
23Apr 12:14 CQ 2nd 50.280 North (W5SAT Brad NV DM26kc 72.193.208.187)
23Apr 12:12 Tnx Tom: (I guess 74 is more than 73, hi.)  (K1JT/7EL700W Joe NJ FN20qi 173.71.96.3)
23Apr 12:11 Hi, Jay. Nice to wrok you this AM.  (W7XU Arliss SD EN13lm 72.106.201.17)
23Apr 12:11 W7XU TNX for QSO Arliss     (K4NKT/6/2/100W/ Jay AL EM64rp 68.35.12.202)
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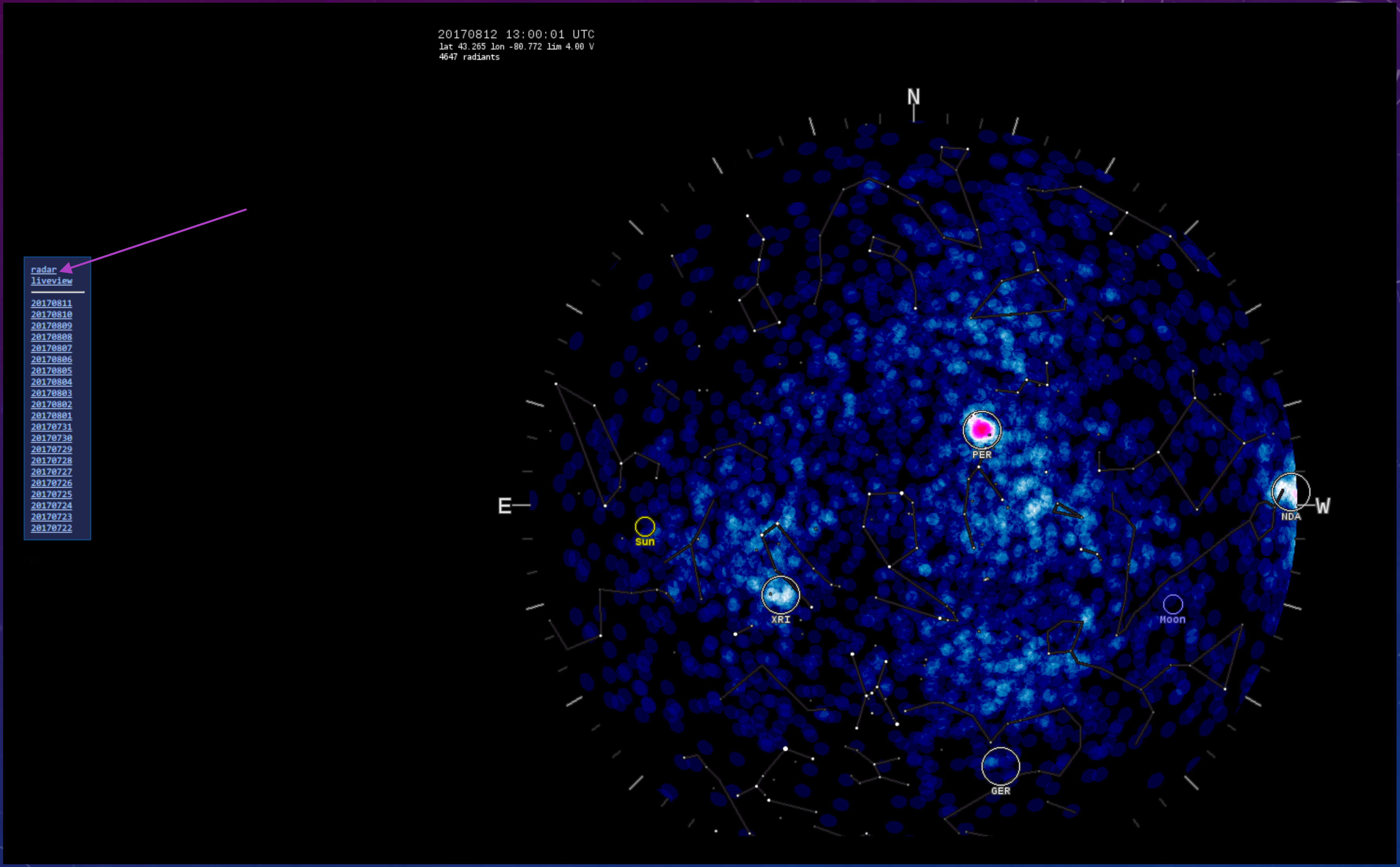
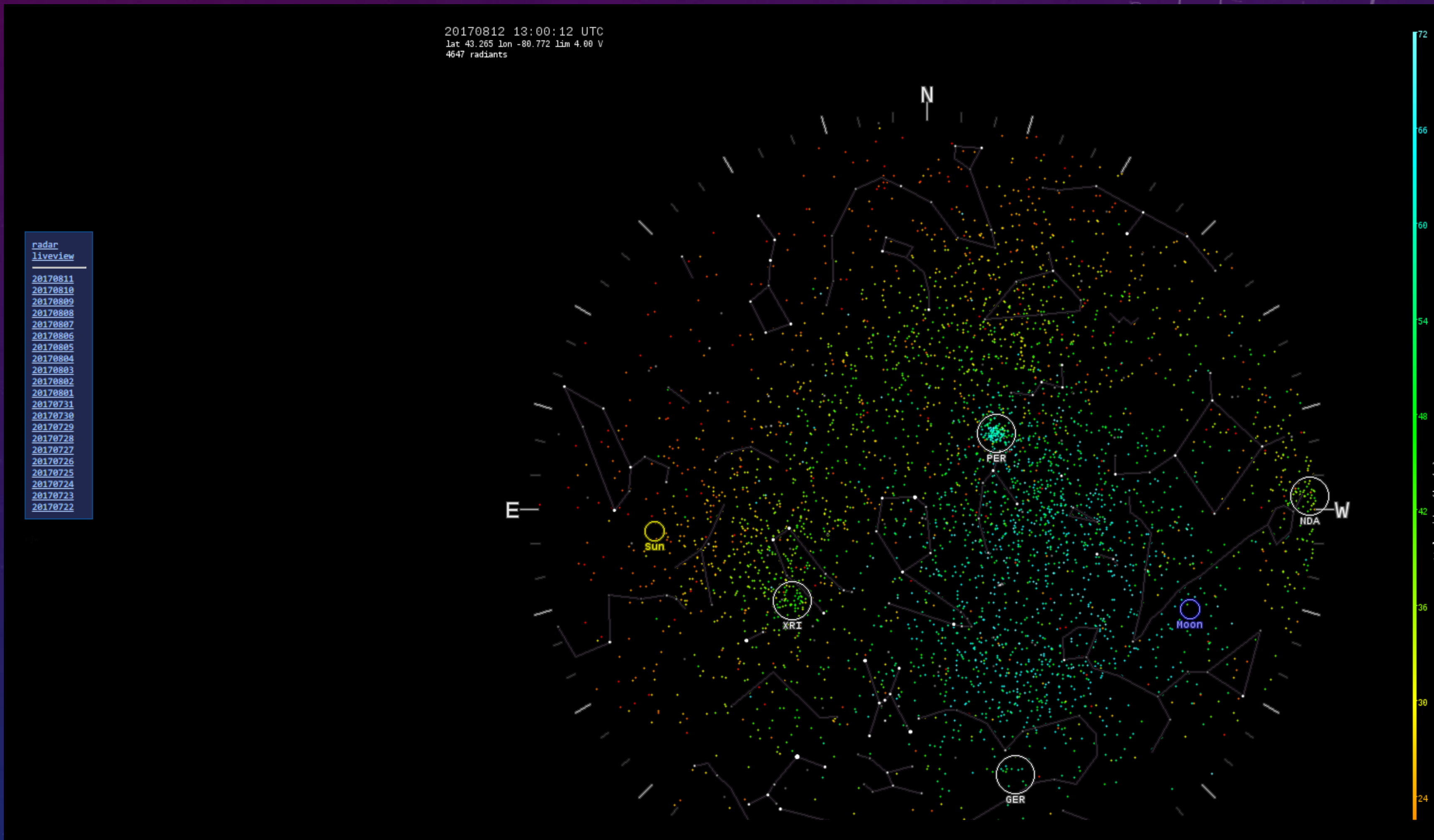
UWO RADAR SITE – FIREBALLS.NDC.NASA.GOV



Perseids 12 August 2017

Perseids 12 August 2017

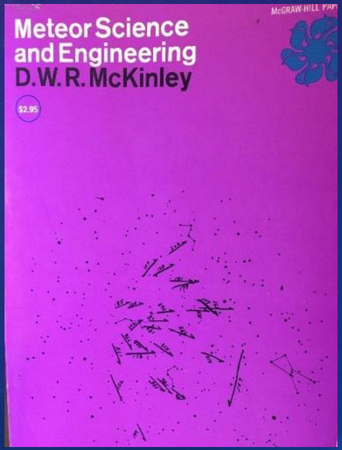


SUMMARY

- Meteor scatter communications is easier than ever thanks to digital modes – MSK144 in WSJT-X
- You can make meteor scatter contacts anytime but they are easier during meteor showers and during the morning hours
- You don’t need a super station but antenna gain, a preamp, and transmit power make it easier
  - Try it even if you are running 50w to a dipole
- Don’t be afraid to ask for help on the Pingjockey and WSJT groups but do a little homework first
  - Get some experience with JT65, JT9 or especially FT8 on HF to get the feel for digital contacts and checkout your rig interface
- Give it a try and ponder what is happening when you hear a “ping” – some dust particle was blown out of a comet and has been wandering around the solar system for hundreds or thousands of years and then meets its fiery end to help you make a QSO

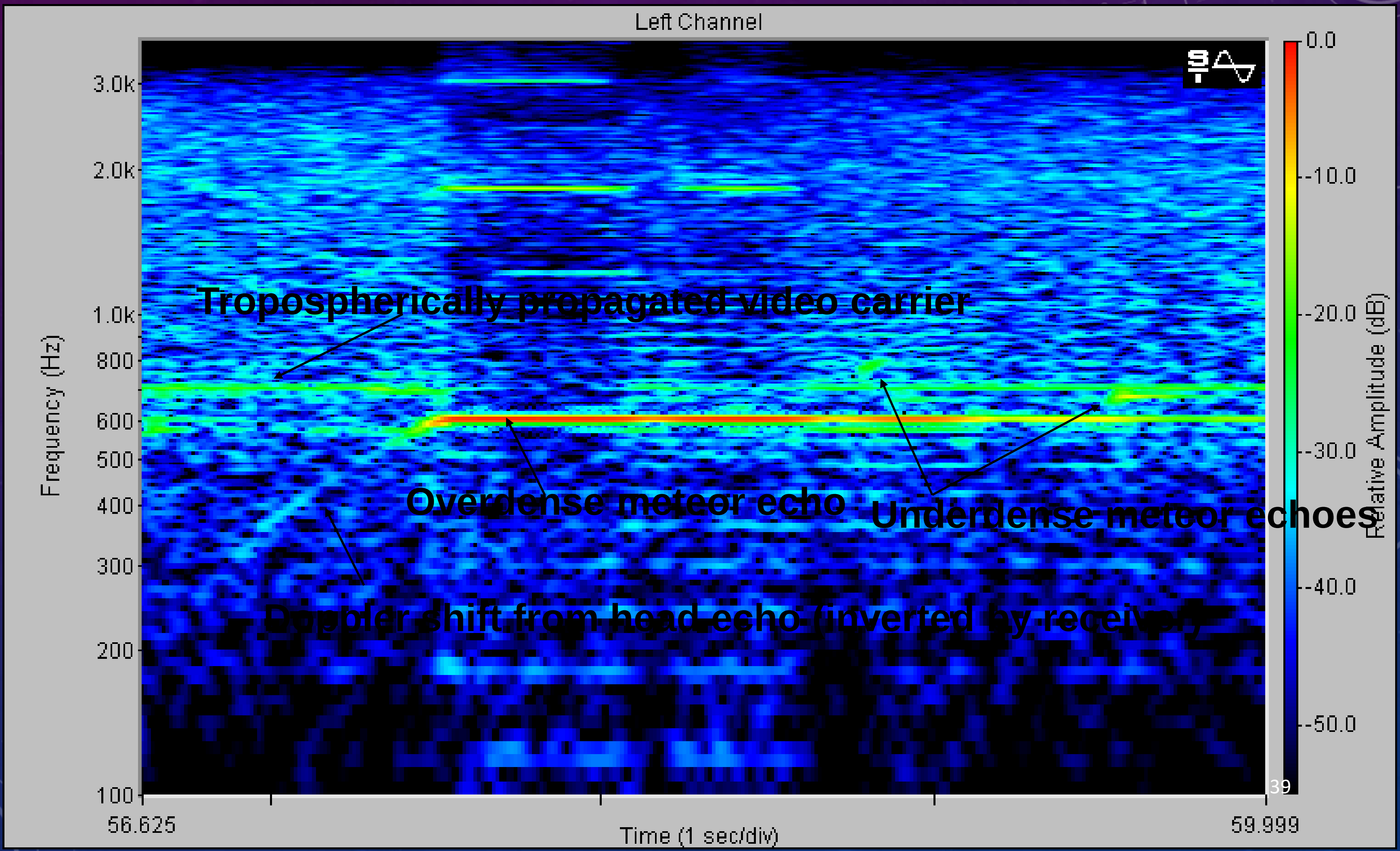
LINKS AND ADDITIONAL RESOURCES

- https://www.pingjockey.net/cgi-bin/pingtalk
- https://fireballs.ndc.nasa.gov
- https://physics.Princeton.edu/plulsar/k1jt/wsjtx.html
- International Meteor Organization radio observation info http://www.imo.net/radio/index.html
- Check NASA Technical Report Server for these slides
  - https://www.sti.nasa.gov/
- Meteor Science and Engineering by D. W. R. McKinley – 1961



BACKUP

Spectrogram of "Bright" and "Faint" Meteors



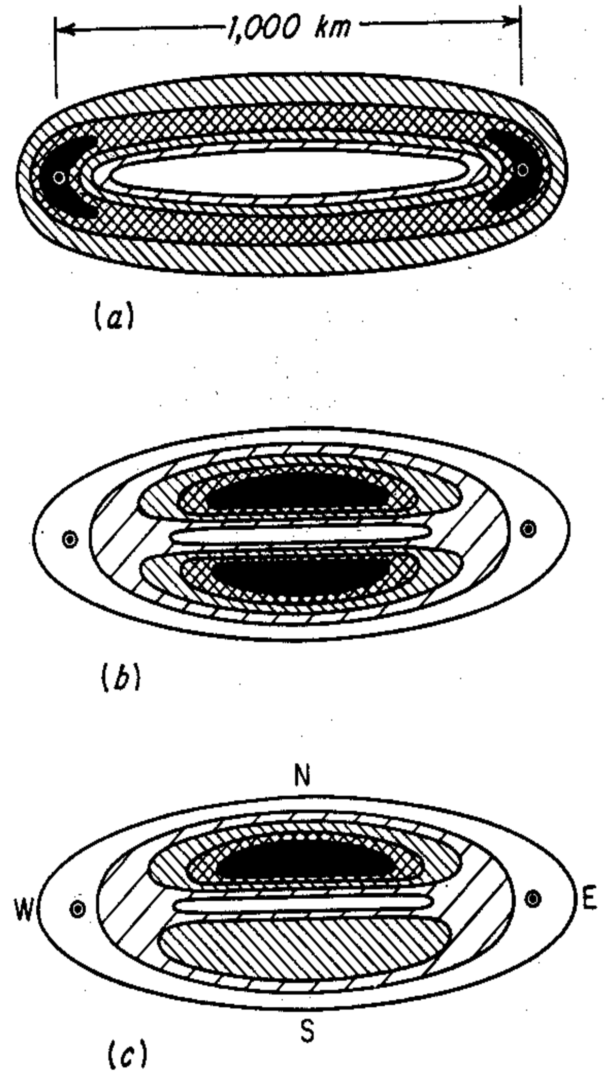


Fig. 9-6. (*a*) The relative number density of forward-scatter echoes, projected on a horizontal plane at a height of 100 km above the stations; (*b*) the relative duration density of forward-scatter echoes for a uniform radiant distribution; (*c*) the relative duration density for a radiant distribution concentrated in the south.

FORWARD SCATTER GEOMETRY

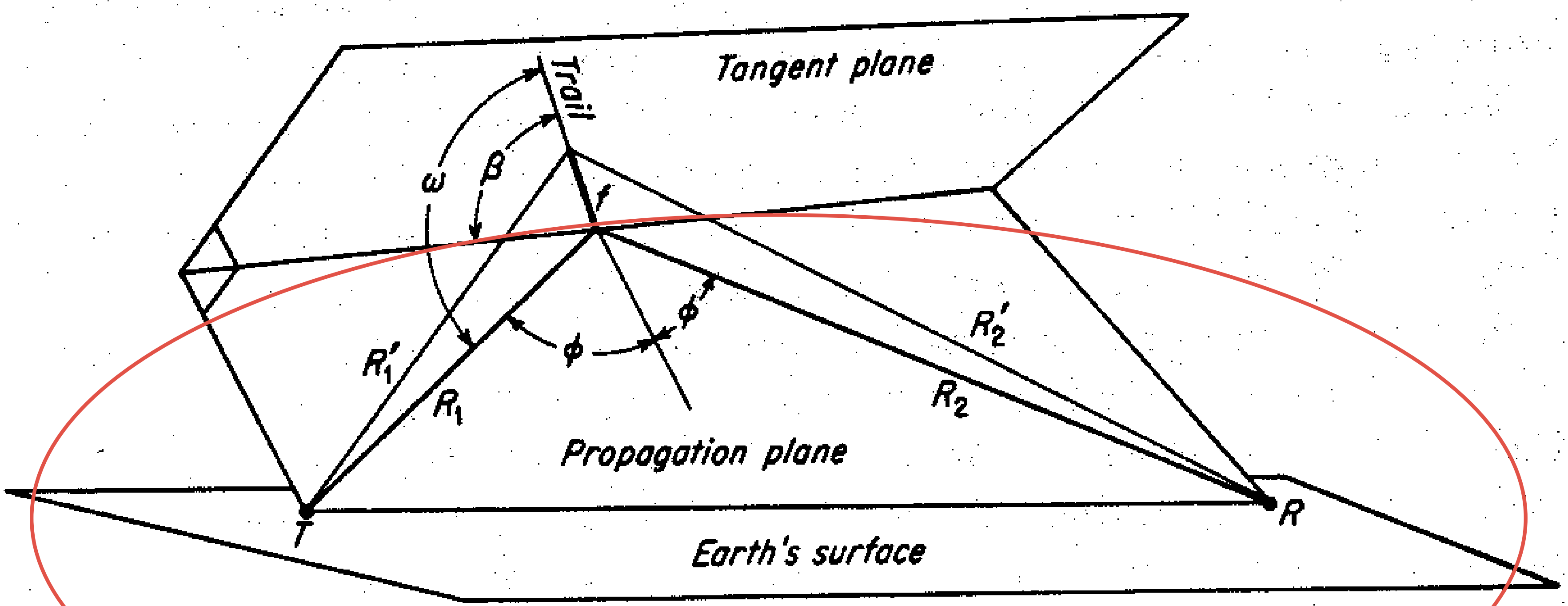
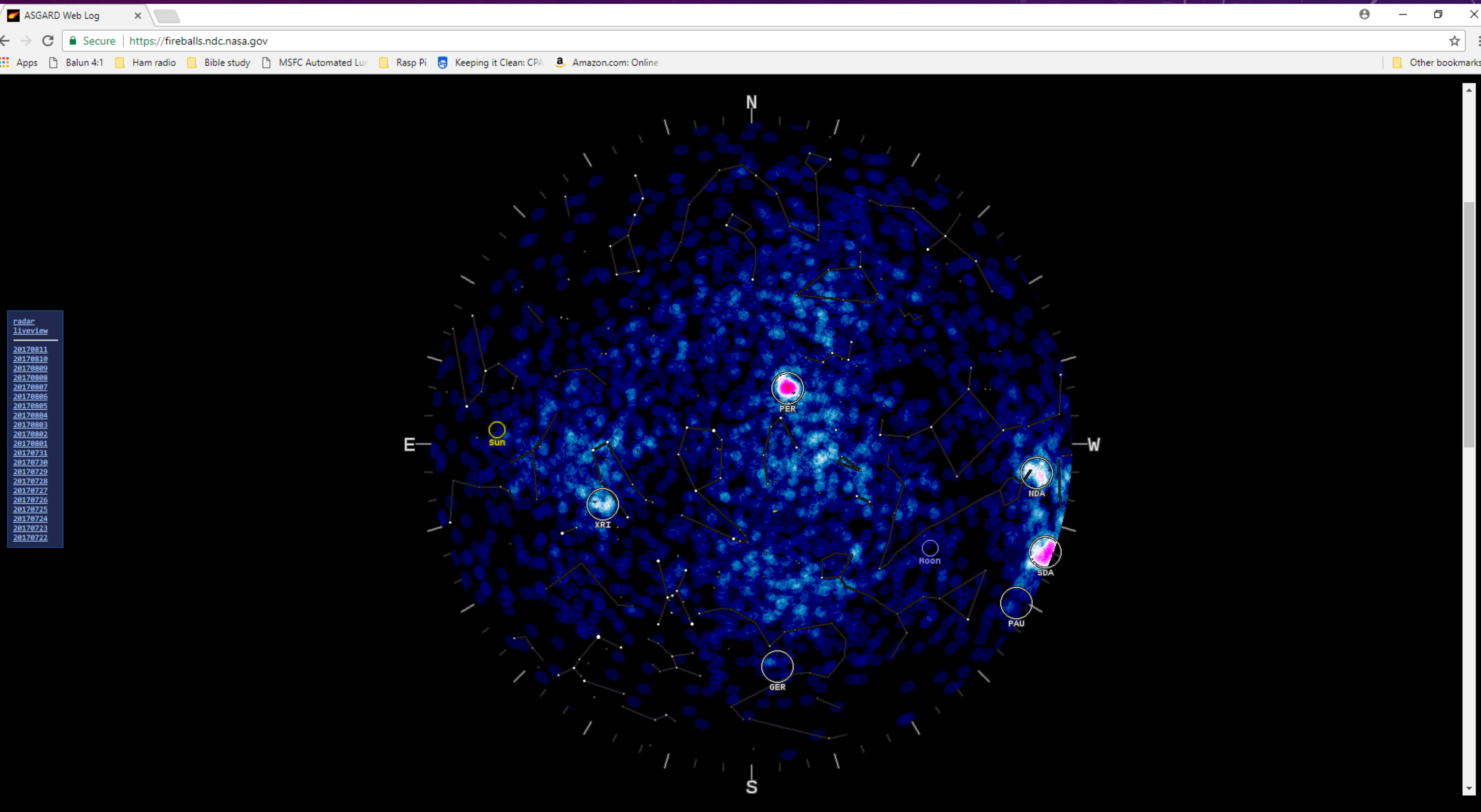
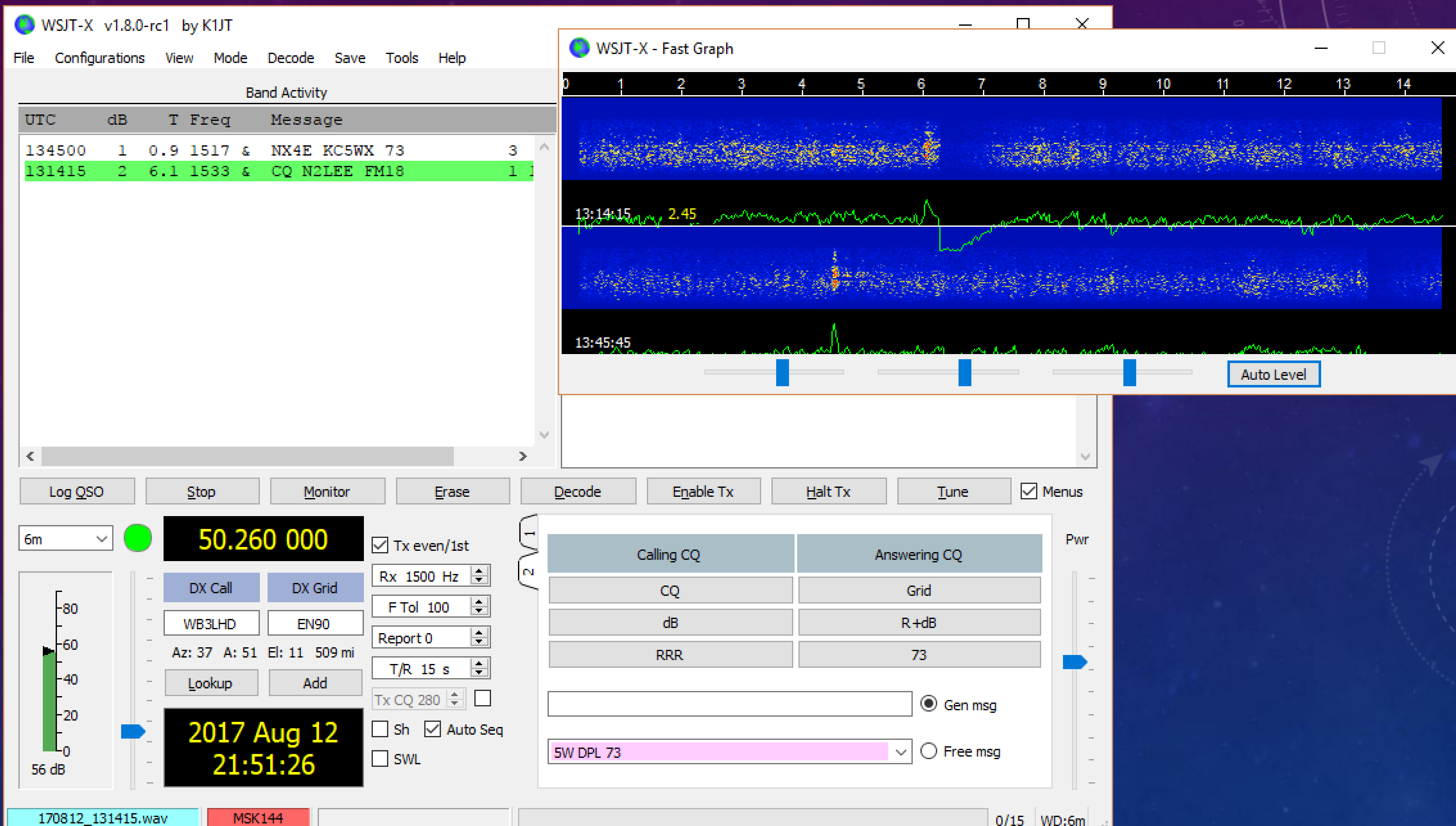


FIG. 9-1. The geometry of forward-scatter involved in the calculation of f, the length of one-half of the first Fresnel zone.

From "Meteor Science and Engineering", D.W.R. McKinley

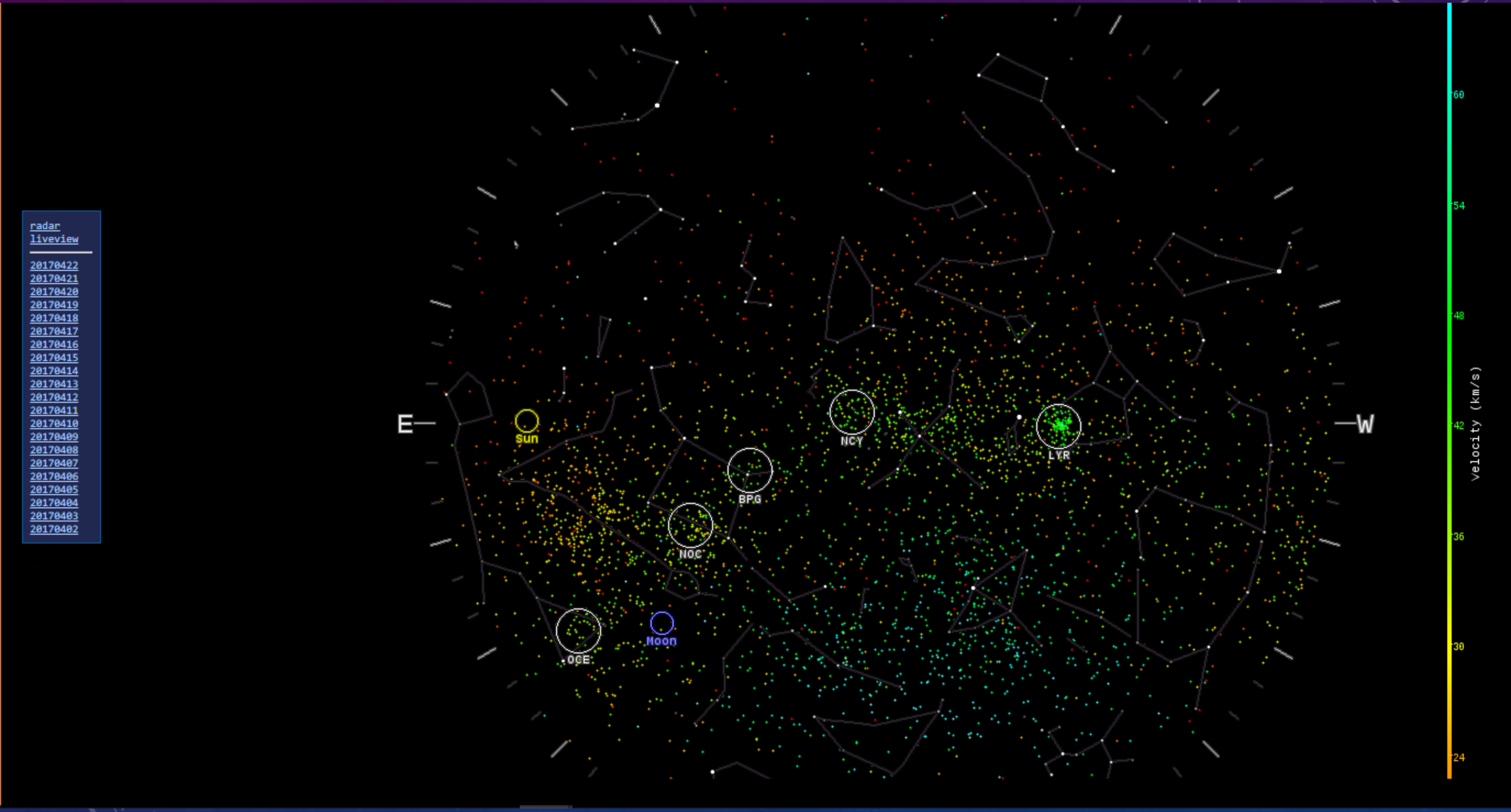
Perseids 12 August 2017



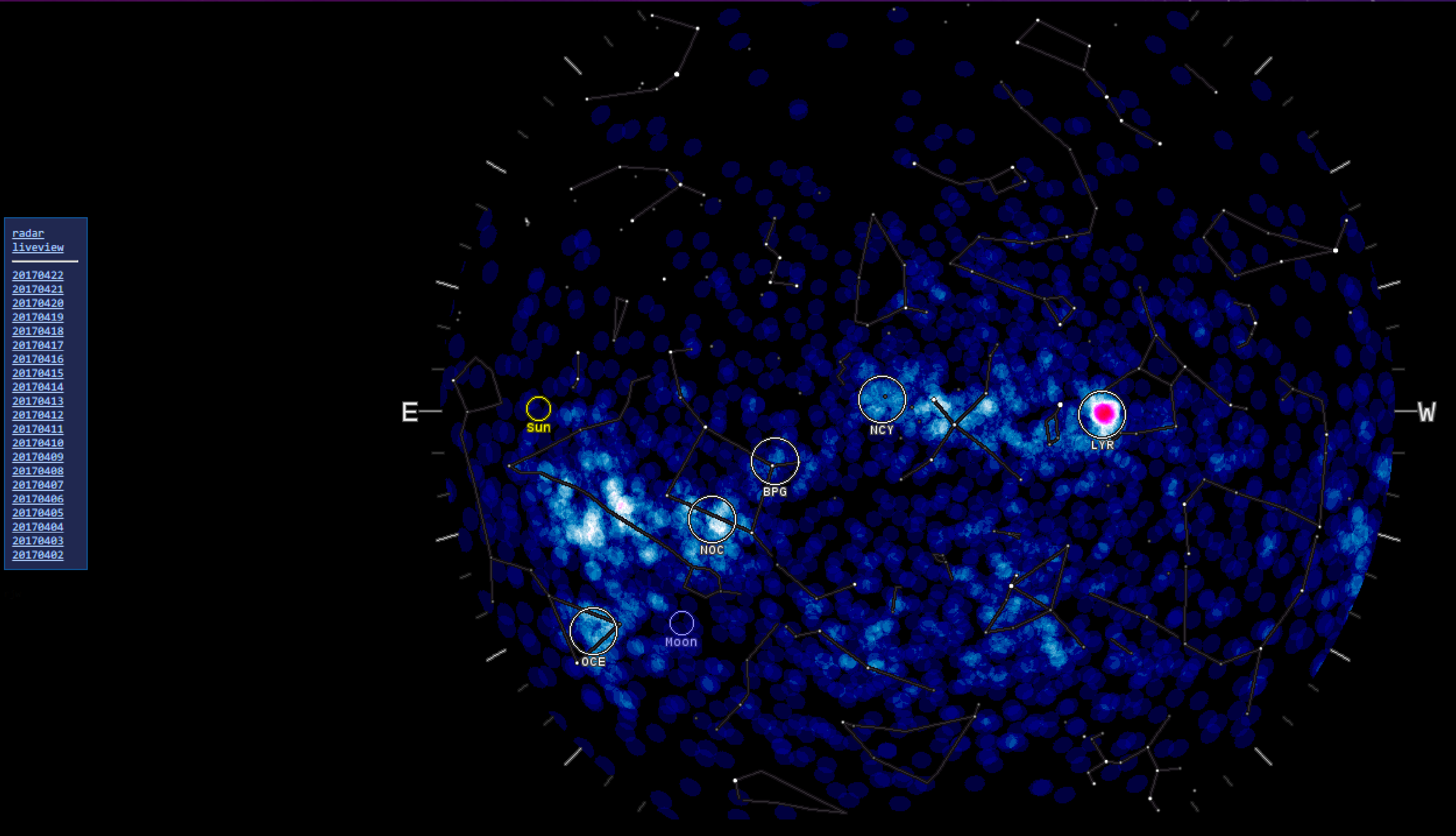


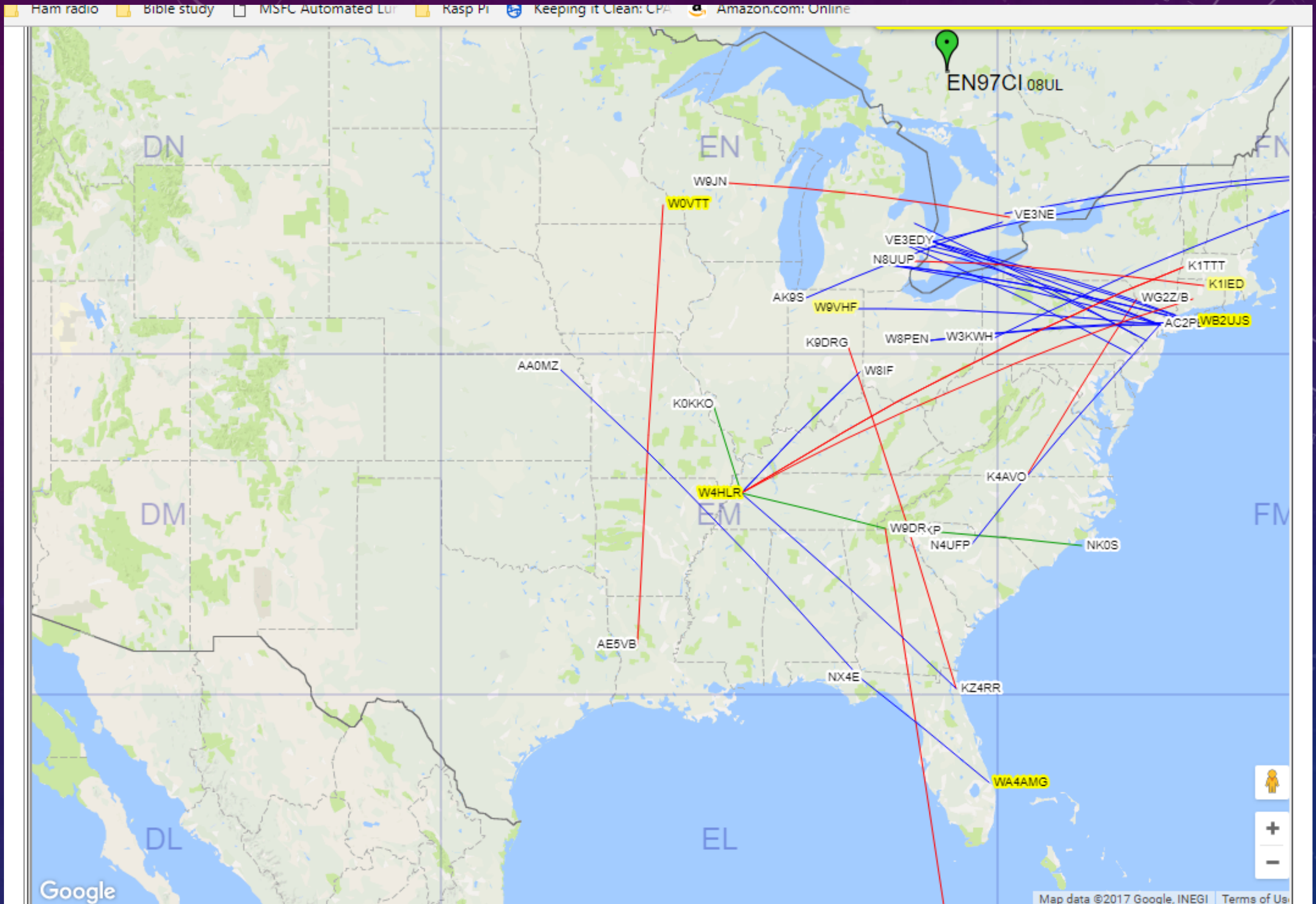
WSJT-X v1.8.0-rc1 by K1JT
File Configurations View Mode Decode Save Tools Help
Band Activity
UTC dB T Freq Message
134500 1 0.9 1517 & NX4E KC5WX 73 3
131415 2 6.1 1533 & CQ N2LEE FM18 1
WSJT-X - Fast Graph
13:14:15 2.45
13:45:45
Auto Level
Log QSO
Stop
Monitor
Erase
Decode
Enable Tx
Halt Tx
Tune
Menus
6m
50.260 000
Tx even/1st
Rx 1500 Hz
F Tol 100
Report 0
T/R 15 s
Tx CQ 280
Sh
Auto Seq
SWL
DX Call
DX Grid
WB3LHD
EN90
Az: 37 A: 51 El: 11 509 mi
Lookup
Add
56 dB
2017 Aug 12
21:51:26
Calling CQ
Answering CQ
CQ
Grid
dB
R+dB
RRR
73
Gen msg
5W DPL 73
Free msg
Pwr
170812_131415.wav
MSK144
0/15
WD:6m

UWO RADAR SITE - SPEEDS

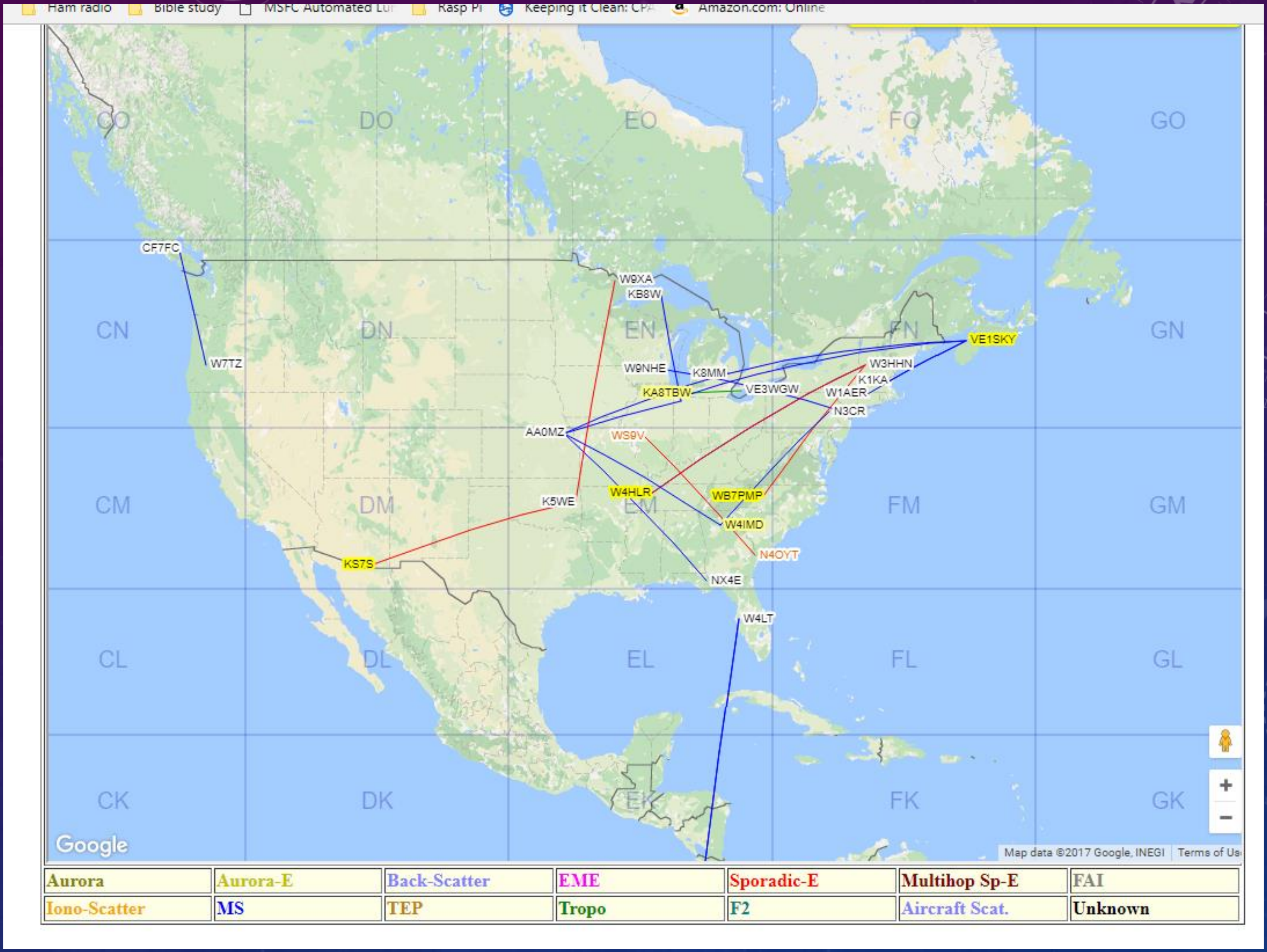


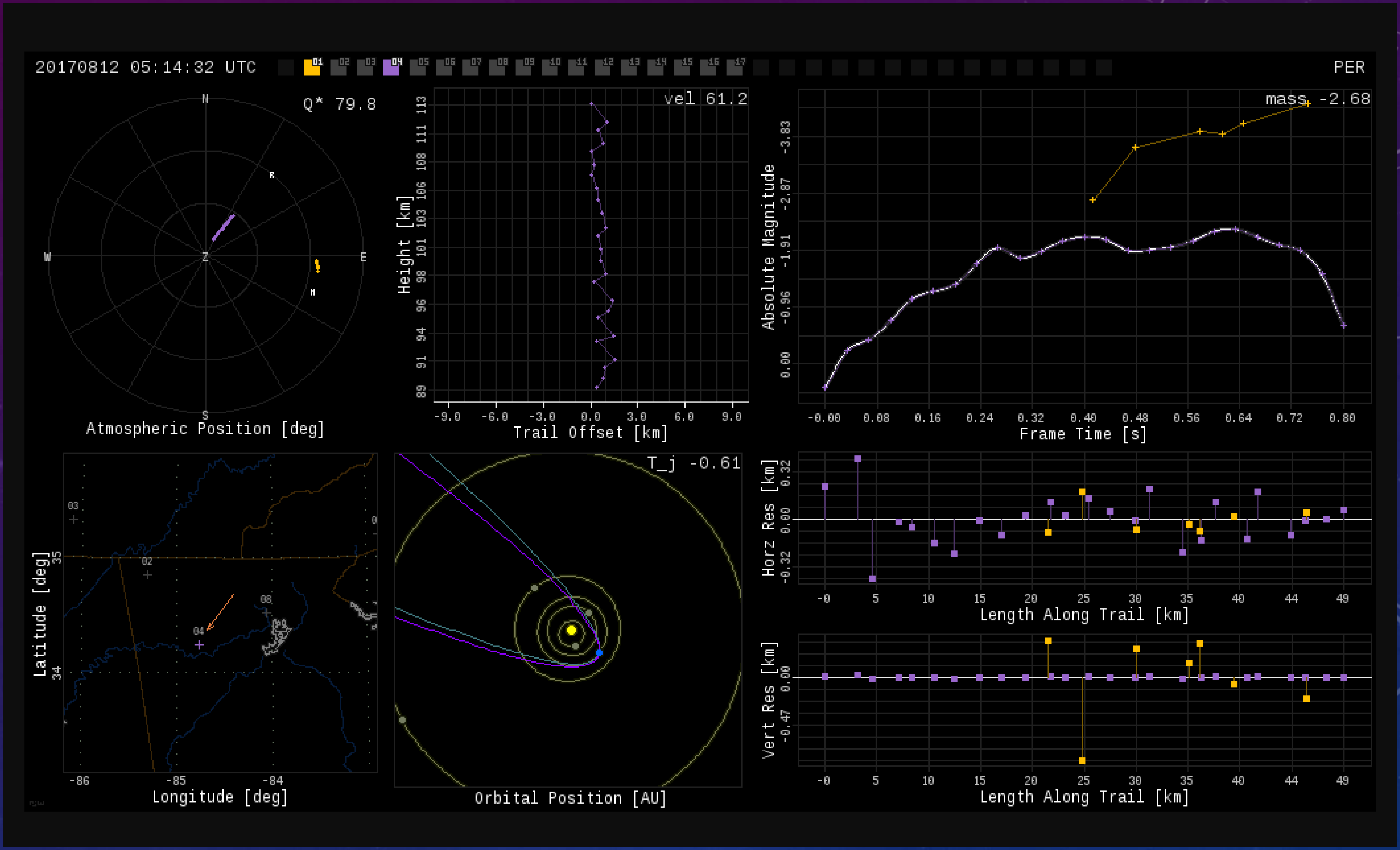
UWO RADAR SITE – FIREBALLS.NDC.NASA.GOV





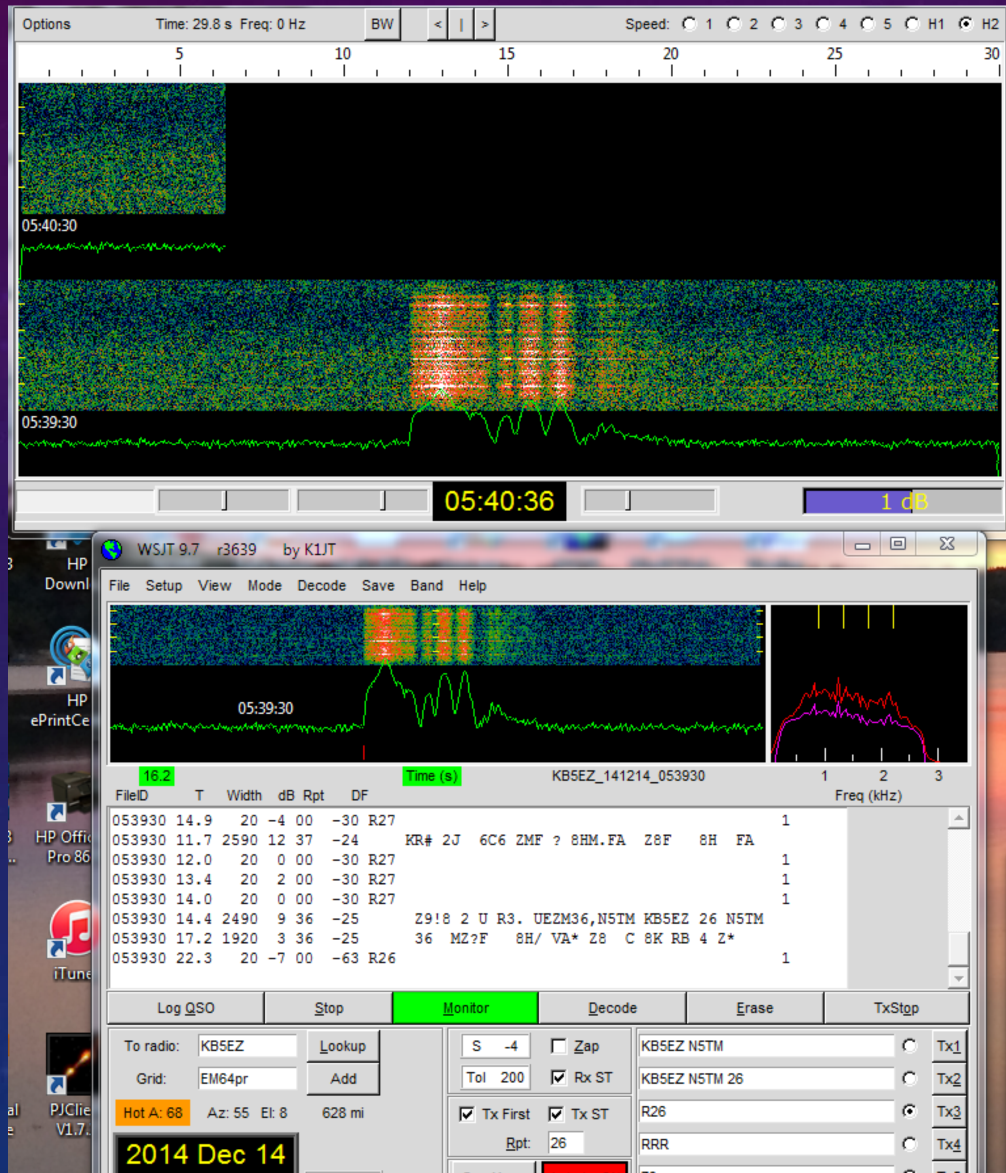
Aurora	Aurora-E	Back-Scatter	EME	Sporadic-E	Multihop Sp-E	FAI
Iono-Scatter	MS	TEP	Tropo	F2	Aircraft Scat.	Unknown


Ham radio
Bible study
Rasp Pi
CO
DO
EO
FO
GO
CN
DN
EN
FN
GN
CM
DM
EM
FM
GM
CL
DL
EL
FL
GL
CK
DK
EK
FK
GK
CF7FC
W7TZ
W9XA
KB8W
W9NHE
K8MM
KA8TBW
VE3WGW
W3HHN
K1KA
W1AER
N3CR
VE1SKY
AA0MZ
WS9V
K5WE
W4HLR
WB7PMP
W4IMD
N4OYT
NX4E
W4LT
KS7S
Google
Map data ©2017 Google, INEGI
Aurora
Aurora-E
Back-Scatter
EME
Sporadic-E
Multihop Sp-E
FAI
Iono-Scatter
MS
TEP
Tropo
F2
Aircraft Scat.
Unknown



20170812 05:14:32 UTC
PER
Q* 79.8
Atmospheric Position [deg]
vel 61.2
Height [km]
Trail Offset [km]
mass -2.68
Absolute Magnitude
Frame Time [s]
Latitude [deg]
Longitude [deg]
T_j -0.61
Orbital Position [AU]
Horz Res [km]
Length Along Trail [km]
Vert Res [km]
Length Along Trail [km]

FSK 441 GEMINID 2014 CONTACT



Rob Suggs KB5EZ October 2017

Ping Jockey Central by N | https://www.pingjockey.net/cgi-bin/pingtalk

Apps | Balun 4:1 | Ham radio | Bible study | MSFC Automated Lu | Rasp Pi | Keeping it Clean: CPA | Amazon.com: Online | Other bookmarks

Ping Jockey Central.

Relief page	Skeds in-progress	CQ Announcements	JT65 Link
Refresh	Look back	Distance/Bearing Locator	Who's Earwigging?
Update User details	AA1YN Callsign database	*** UNREGISTERED USER - POSTS DISABLED ***	Refreshed 12Aug 13:20

Due to recent abuse of this system, you will be unable to post any messages until you complete the User Details page
This page is to be used only for the purposes of discussing matters related to amateur radio meteor scatter communications.Any non-meteor scatter use is strictly prohibited.

That means **DO NOT USE THIS PAGE TO WORK JT65 or for General chit-chat.**

Remember, in North America, 50.260MHz and 144.140MHz are calling not operating frequencies.

Exchanging any contact details on here before you're complete, invalidates the contact, and, if it's not HIGH-SPEED METEOR SCATTER, it doesn't belong here!

To have your callsign and locator automatically appended to each message that you send, an html cookie can be stored by your web browser.
The information that is stored in the cookie is your callsign, firstname, and Maidenhead grid locator.
To enable this feature, please press the "Update User details" button shown above.

Enter your message here [ ] Go!

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DDMMM  UTC
12Aug 13:20 AC0RA use TOL 200 as I am higher than u.    (WA4CQG Dale AL EM72fo 71.91.59.70)
12Aug 13:20 KG5CCI any chance for me    (WA5ZFP Ronald LA EL49ll 162.203.219.199)
12Aug 13:20 ***** CQ 144.146, west, 2nd, SH=on *****    (KU8Y/50THRU432 Ken MI EN61uw 104.5.18.255)
12Aug 13:20 RR Gary,,Tnx try... (W5LDA Larry OK EM15xu 192.169.27.149)
12Aug 13:20 kc5wx 1469 1441     (N0KK/6/2/KW Kirk MN EN35ha 97.116.188.174)
12Aug 13:20 KB0ZOM Ben, Thanks for a new grid on two!  73       (KU8Y/50THRU432 Ken MI EN61uw 104.5.18.255)
12Aug 13:20 KC8YJB Not decoding you. Your CW ID FB.     (K5VWW Orville TX EL29fq 45.29.161.39)
12Aug 13:20 even got ur cw id!  (KB0ZOM Ben NE EN00tn 24.159.170.45)
12Aug 13:20  FM19          1  6 -0.6132015   8  2.2 1506 &  CQ W3IP FM19          1  1 -0.1132015   9  3.0 1485 &  CQ W3IP FM19          1  1 -0.2132015  10  5.2 1471 &  CQ W3IP FM19       (K0TPP Larry mo EM48rj 71.11.138.45)
12Aug 13:20 131815   4  5.6 1474 &  CQ W3IP FM19          1  5 -0.4131815   6  5.8 1474 &  CQ W3IP FM19          1  0  0.3131915   0  4.4 1441 &  CQ W3IP FM19          2 13 -1.4131945   0  9.2 1471 &  CQ W3IP     (K0TPP Larry mo EM48rj 71.11.138.45)
12Aug 13:20 W7XU Arliss RR see you then (K1OR John NH FN42ir 24.91.109.215)
12Aug 13:20 W5LDA-Larry, ni here too.  Tnx very much for try.  73.      (N2AMC Gary NY FN30iv 70.214.77.187)
12Aug 13:20 NX4E - actually getting some pings on you.          (W5TN David TX EM00wf 38.97.13.36)
12Aug 13:20 wa4cqg running gl   (AC0RA/2M Wyatt IA EN42ll 69.63.8.198)
12Aug 13:20 KU8Y - tnx sir!     (KB0ZOM Ben NE EN00tn 24.159.170.45)
12Aug 13:20 CQ 50.263 Beaming north.. first taker I can hear..  (KG5CCI Dave AR EM34st 107.77.198.225)
12Aug 13:20 AC0RA just as we want to stop - great rocks, Murphy has his way     (KC4PX Ivars FL EL98qg 107.145.146.138)
12Aug 13:19 kc5wx One way rocks..I guess..      (N0KK/6/2/KW Kirk MN EN35ha 97.116.188.174)
12Aug 13:19 131818  Tx      1500 &  KB5EZ N2LEE -02  On .255    (N2LEE Lee VA FM18hx 108.48.202.194)
12Aug 13:19 K1OR -- How about 0400 UTC tonight? Will meet you on here.  (W7XU Arliss SD EN13lm 72.104.230.244)
12Aug 13:19 RR Andy.... (W5LDA Larry OK EM15xu 192.169.27.149)
12Aug 13:19 AC0RA good QSO      (KC4PX Ivars FL EL98qg 107.145.146.138)
12Aug 13:19 KG5CCI - Tnx for hanging in there Dave, Tnx new Grid... 73  (K5WE Jeff OK EM25ex 75.89.6.23)
12Aug 13:19 W5LDA would like to try when available -- good pings here   (N2NT/6/2/222 Andy NJ FN20si 108.53.188.123)
12Aug 13:18 QRV 2m      (N4OGW Tor MS EM53nk 104.8.40.200)
12Aug 13:18 ~~CQ 144.153 pointing NE 1st~~      (W4YZJ Jeff AL EM64ru 173.26.104.239)
12Aug 13:18 kc4px tnx that was tough one        (AC0RA/2M Wyatt IA EN42ll 69.63.8.198)
12Aug 13:18 K1OR -- Found reference that says NE-SW best  0100-0300, 0900-1100 LOCAL times. Not sure for E-W.   (W7XU Arliss SD EN13lm 72.104.230.244)
12Aug 13:18 kc4px sweet. log it (AC0RA/2M Wyatt IA EN42ll 69.63.8.198)
12Aug 13:18 N2AMC Gary..Not looking too promising at this distance....  (W5LDA Larry OK EM15xu 192.169.27.149)
12Aug 13:18 W7XU Arliss need to leave now for charity car show. Pse send me an email on what you wud like to try. Completly open my end (K1OR John NH FN42ir 24.91.109.215)
12Aug 13:18 N0KK Kirk,   Have not heard or seen anything.....   (KC5WX Gene TX EM13rs 69.92.1.15)
12Aug 13:18 N1JEZ Thanks Mike   (WW2Y Peter NJ FN20qj 98.221.128.44)
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